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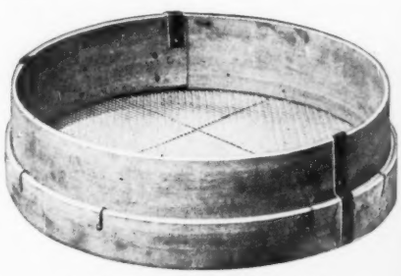

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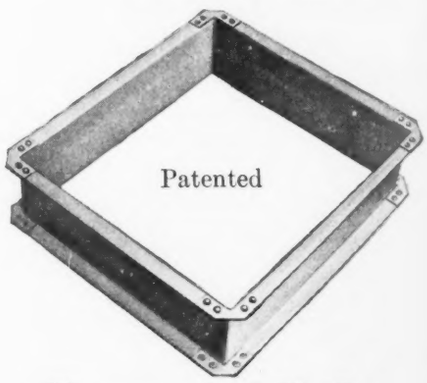

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THE FOUNDRY

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CYLINDER MOLDING IN AN ENGLISH SHOP

Method of molding locomotive cylinders in the foundry operated by the Midland Railway Co., Derby, England

At a recent meeting of the Birmingham branch of the British Foundrymen's Association, held at Birmingham, Eng., H. Pemberton delivered an address on "Cylinder Molding in English Foundries."

Mr. Pemberton has been employed for eight years in the Midland Railway Co.'s works, Derby, England, and the illustrations accompanying this address were made from photographs taken in the Midland Railway Co.'s shop. Mr. Pemberton spoke in part as follows:

"I chose the locomotive cylinder for my subject, not because we have no other cylinders to make in our works, for it is our privilege to make other varieties as well, but no cylinder requires more careful work than the locomotive cylinder. I do not say this as a compliment to myself, but in the interest of the firm and public. If the stationary engine comes to grief there is, in the majority of cases, only an engine to repair and no loss of life is involved. If a marine cylinder comes to grief, the vessel continues until its

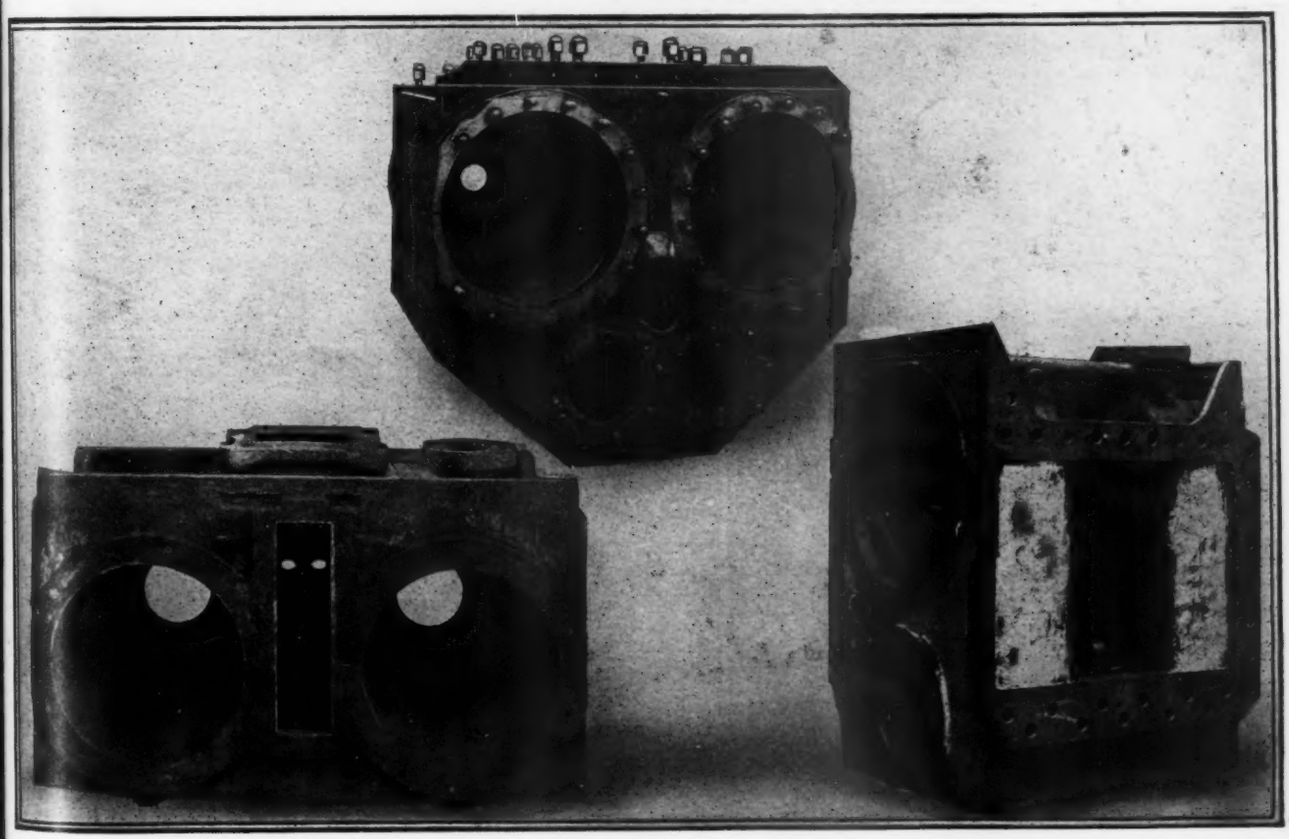


Fig. 2—Front View of Locomotive Piston Valve-Cylinder Casting

Fig. 1—Front View of Locomotive Twin-Cylinder Casting

Fig. 3—High-Pressure Locomotive Cylinder in the Position in Which It is Cast

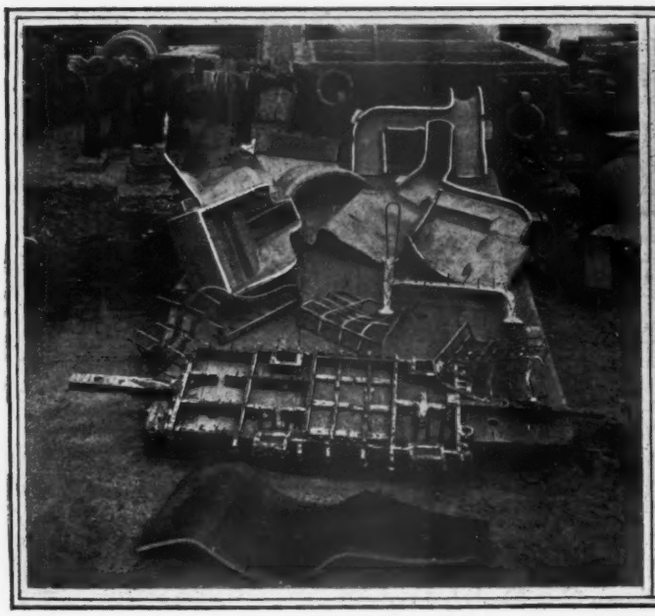


FIG. 4—CORE BOXES AND CORE BARS FOR TWIN-CYLINDER STEAM CHEST CORES

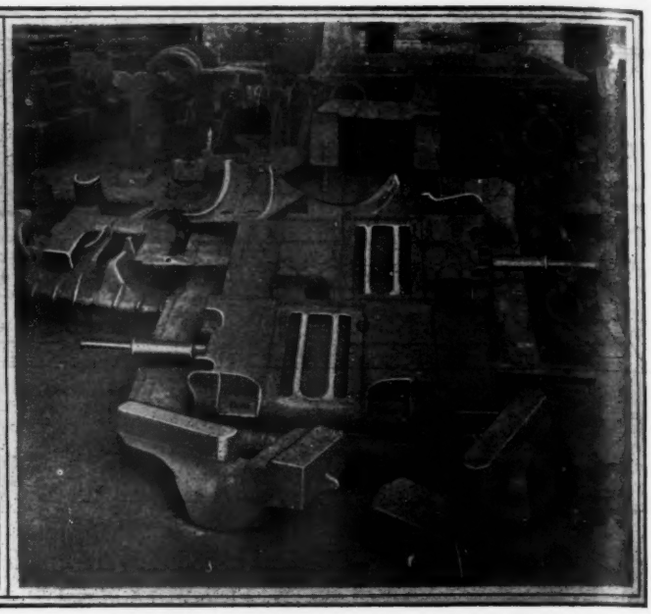


FIG. 5—CORES FOR TWIN-CYLINDER STEAM CHEST BEFORE BEING ASSEMBLED ON THE FRAME

momentum is exhausted, but if the locomotive cylinder comes to grief, and a passenger train is concerned, the result is almost inevitably a serious catastrophe. The locomotive cylinder while doing its work is subjected to a great deal of oscillation and vibration to which the stationary cylinder is not liable. The matter is further complicated by the position in which the cylinders of the locomotive are compelled to be placed, either outside of the engine frames or in the center of the engine front. This exposes the cylinders to the keen velocity of the winds and frosty air in the winter months.

"In the production of locomotive cylinders, or any other cylinder of

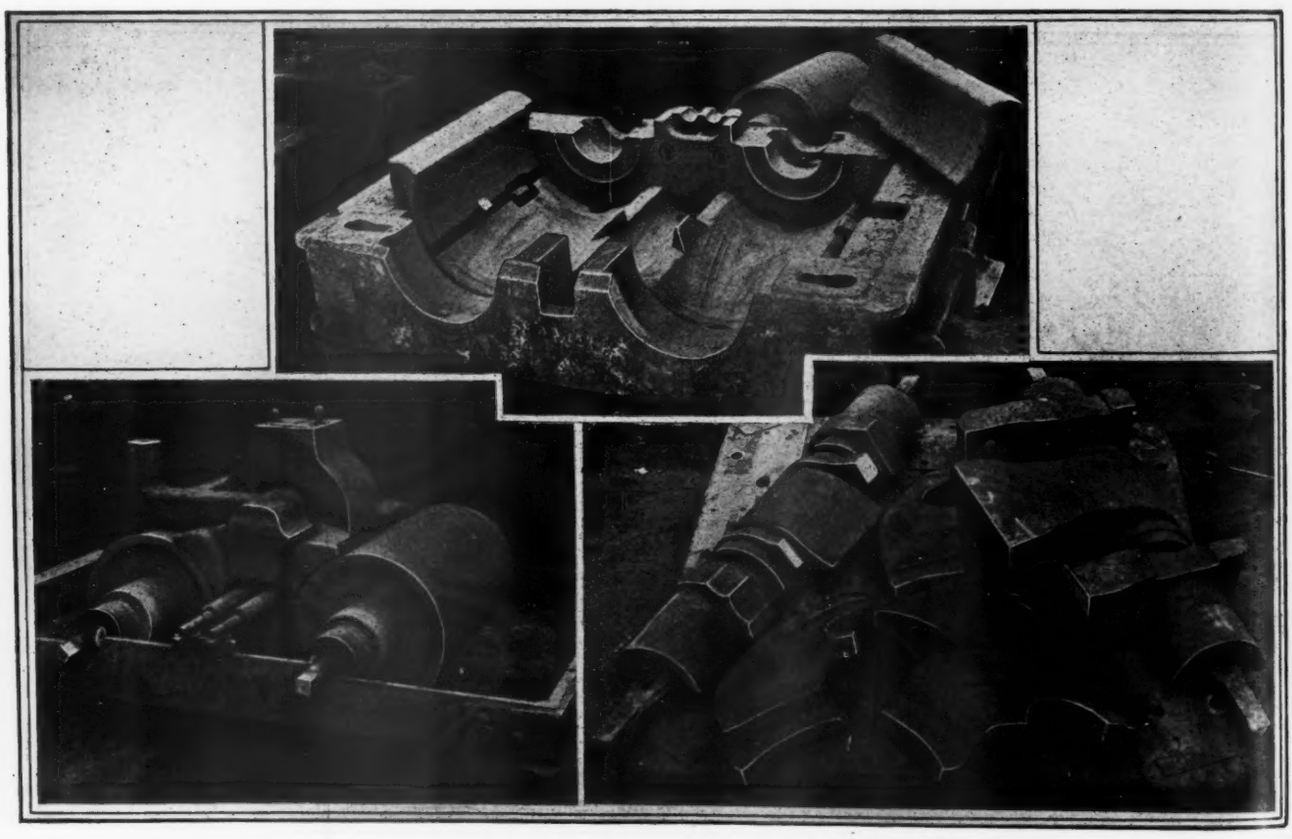


FIG. 7—DRAG OF TWIN-CYLINDER MOLD, SHOWING TWO CORES FOR SIDE OF MOLD, THE ONE TEMPORARILY IN POSITION AND THE OTHER ON TOP OF THE FLASK

FIG. 6—CORES FOR TWIN-CYLINDERS ASSEMBLED ON FRAME BEFORE BEING LOWERED INTO THE MOLD

FIG. 8—CORES WHICH FORM ONE PISTON VALVE CYLINDER CORE

which a large quantity is to be made, the pattern must be considered very carefully, and a small amount of money spent in patternmaking will effect great savings in the molding cost. The pattern is made with numerous loose pieces, which entail an extra expense. The flasks also require special attention to enable the molder to do his part of the work as easily and speedily as possible. We use one style of flask for a variety of cylinder patterns. This is a plain flask with openings in the sides for the central part of the cylinder, and by having a number of loose bars of various shapes which fit around the different sizes of the cylinder patterns and by bolting them to the side of the flask, the molder is saved the work of putting lifters or gaggers into the mold, which, in addition, is made much firmer and stronger. There are several different types of cylinders in use, but I will deal with only the three which are most commonly employed; they are the twin cylinder, Fig. 1, the piston-valve cylinder, Fig 2, and the high-pressure cylinder of the compound-cylinder locomotive, Fig. 3.

"The twin cylinder is made with only one joint in the mold, but the flask is made in four parts for the convenience of the molder when ramming his mold. The two middle parts of the flask are made quite plain and into these, loose bars are bolted, while the top and bottom sections of the flask have bars extending across their entire length. One-half of the pattern is first placed on the turn-over board, of which we have a number especially for cylinders. The loose pieces are put into their places on the pattern and are temporarily fastened together with dowel pins. Where the cylinder is of an exceedingly uneven thickness, chills are placed in the pattern in various places. With an iron that is going to be very close grained and of great strength, contraction cavities will form unless some preventive is used to arrest the molten metal before this has had time to take place. These chills are first heated and are then dipped in pitch, so that when the mold has been cast, this thin coating of pitch burns and forms a film of gas between the chill and the molten metal, thus preventing the metal from burning into the chill.

"The facing sand for these molds is composed of 20 per cent of manure and 80 per cent new sand. This is ground as loam, is dried in the stove and is then taken back to the sand mixing machine; 11 per cent of this mixture is again ground with 3 per cent of manure, 83 per cent of new sand and 3 per cent of sea coal. This sand is used as a facing sand on the pattern. The flask is next partly filled with black sand, which is used slightly damper than the black sand usually employed for green sand work. By using the sand in this manner, a much stronger mold is made. The mold is then rammed up to the top of the first part of the flask and the second part of the flask, which has been left off for the convenience of the molder while ramming the first section, is then placed in position, the two are clamped together and the ramming is continued to the finish of this part of the mold, which is then vented and rolled over. After rolling over, the cope half of the pattern is placed over the drag half, parting sand is thrown on the joints, the facing sand is placed around the pattern and the first portion of the cope half of the flask is then placed in position. The loose bars are

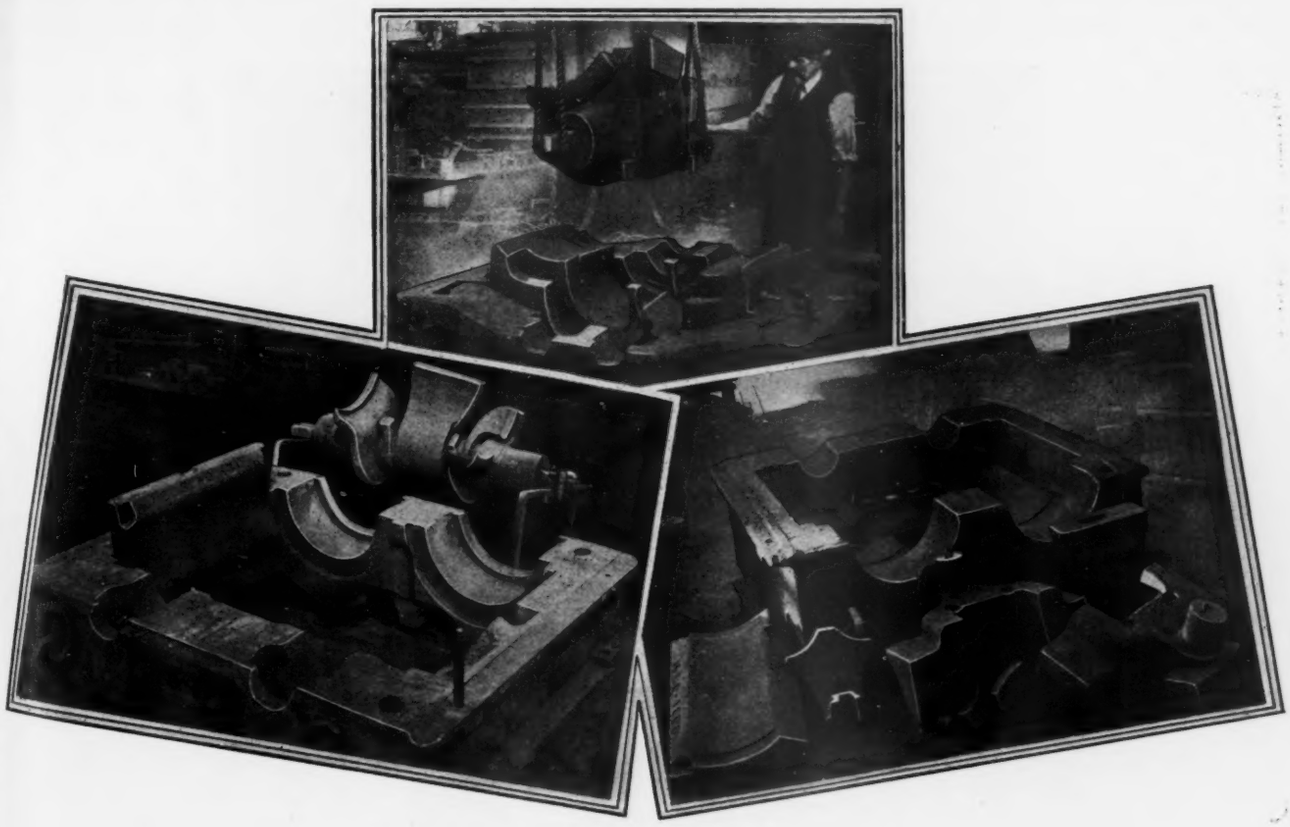


FIG. 9—LOWERING ASSEMBLED VALVE CORE INTO DRAG PISTON VALVE CYLINDER MOLD

FIG. 10—CHEEK OF PISTON VALVE CYLINDER MOLD, SHOWING ONE OF THE SIDE CORES IN TEMPORARY POSITION AND ONE OF THE VALVE CORES IN THE BACKGROUND

FIG. 11—COPE HALF OF MOLD, SHOWING MAIN STEAM PIPE CORES, EXHAUST CORES, ONE OF THE CORES FOR THE SIDE OF THE MOLD AND SEVERAL LIGHTENING CORES

placed in position and ramming is continued to the top half of this part of the flask. The second part of the cope flask is then clamped in position. As the exhaust and main steam pipe core prints extend almost to the top of the flask the sand is cut away, leaving an opening for these cores to extend through. The mold is then parted, the patterns withdrawn and, after finishing, the mold is dried.

Cores.

"In Fig. 4 is shown a variety of cast iron core boxes, as well as core irons used in making cores for the twin-cylinder castings. These core irons save a large amount of labor when cleaning the castings, as they can be easily broken up. These cores are also dried on plates which are of the same shape as the cores. This saves packing these cores with sand to prevent warping, which would be necessary if a straight plate were used. It is unnecessary to describe how these cores are made with the exception of the steam passage core. When making this core, sand to the depth of ½ inch is placed in the shell and the core iron is then clay-washed and bedded in the sand; a little more sand is then added and wax wires are laid in about 1¾ inches apart, extending through the holes in the end of the shell. The top half of the box is then bedded on the sand and the core is rammed up as far as possible from the sides, which are left open for that purpose. It is impossible to conveniently strickle these cores, as they have several radii. The barrel cores are struck up in the ordinary way, Fig. 5. These cores, together with the exhaust, main steam pipe and steamway cores form the double steam chest.

"I will now describe how these cores are put together before they are set in the mold. First we employ a square frame made about 8 inches larger than the outside of the flask. On this, one-half of the steam chest core is laid, the port core having had its binding wire threaded around the core iron. The wire is then passed through the core print in the steam chest core, the steam port core is put into the print and is secured by tieing the wire around a piece of ¼-inch iron, which has been embedded in the back of the steam chest core. The core print in the steam chest core is made ¼ inch wider than the steam port cores, and the latter are then set to the outside edges of these core prints. This is done to enable the molders to ram sand in this ¼-inch of space. Furthermore, the steam port core is made very firm and thus no chaplets or supports are required between the steam port core and the steam chest core.

Assembling the Cores.

"A thickness piece is laid on the steam chest core when the steam port core is first put in the print, but this is removed when the port core is secured. The four port cores having been fastened in their core prints in the two halves of the double steam chest, the two halves are then bolted back to back on the frame as shown in Fig. 6. The exhaust cores are next fitted into the prints provided in the steam chest cores and a hole is bored through the exhaust cores to the double steam chest. A piece of binding wire is threaded through all the cores and they are fastened together by twisting this wire around a piece of ¼-inch iron, which has been bedded in the exhaust core, as shown in Fig. 5. This secures the cores on the bottom and they are finally carried on the top of both cores by fastening a piece of

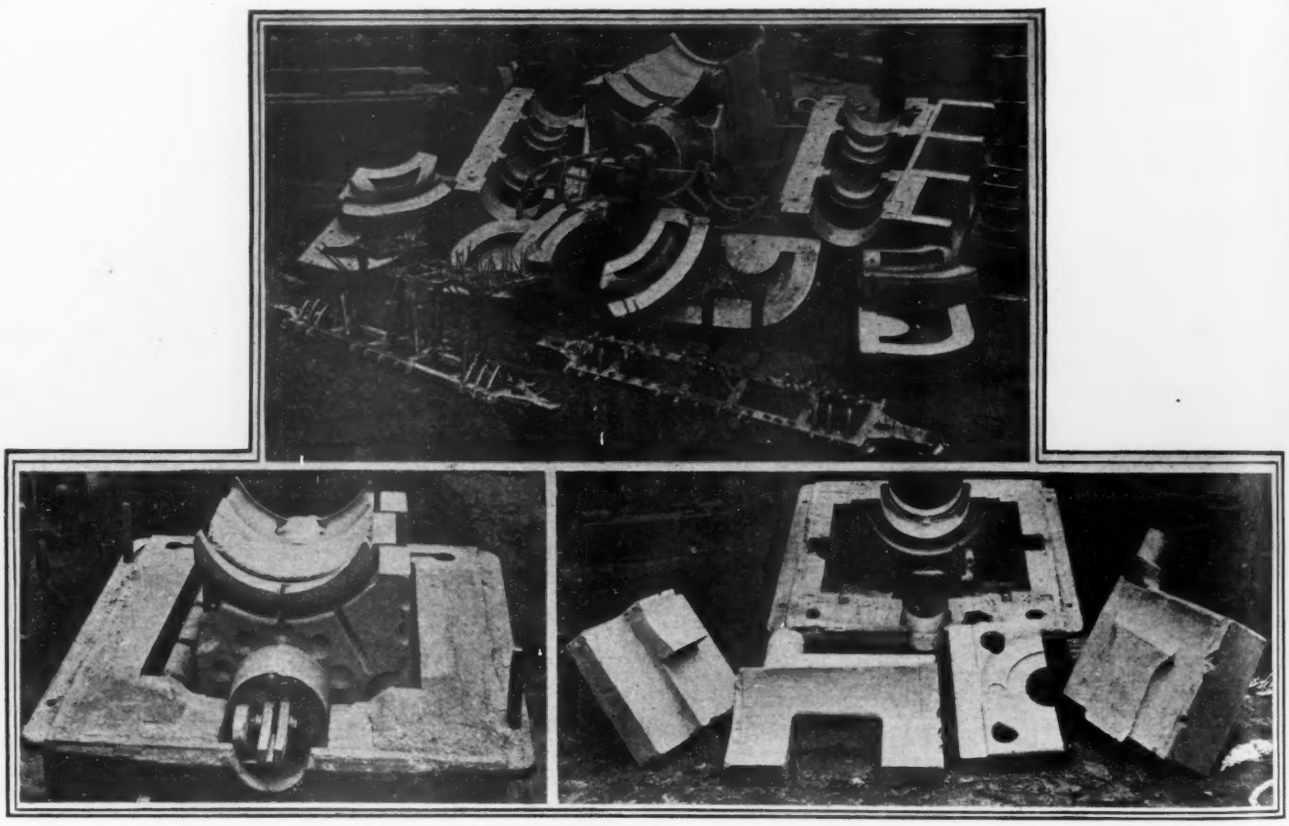


FIG. 12—CORE BOX, CORE BARS AND VALVE CORE ASSEMBLED ON TRESTLE, READY FOR THE MOLD

FIG. 13—DRAG HALF OF THE HIGH-PRESSURE CYLINDER MOLD WITH CORE IN POSITION

FIG. 14—CHEEK OF MOLD FOR HIGH-PRESSURE CYLINDER, SHOWING MAIN STEAM PIPE CORES, TWO SIDE CORES AND THE END CORE

binding wire around the piece of projecting core iron left for this purpose, Fig. 6. The barrels are next put on the frame and the main steam pipe core is set into the prints left in the steam chest core, bolts having been cast in the steam chest core iron. This core is then bolted up to the steam chest and this arrangement also serves the purpose of bolting the halves of the double steam chest together on the top.

"Provisions are then made for venting. The inside of the cylinder which is complete on the frame is lowered into the mold, the frame dropping over the flask and the cores into the core prints. In Fig. 7 the drag half of this mold is shown, before the inside cores have been lowered into their prints. Two cores are made for the side of the mold. These are set into their prints and are held back by eye-bolts, which are passed through holes cast inside of the flask for the purpose. The lower cheek is then set over the drag and the two flasks are clamped together. The mold is then placed in the oven to dry. After the mold has been dried, the runner and riser boxes are set in position. Pieces of tin are placed over the runners, which gradually melt as the metal is poured and facilitate keeping the runner box filled with metal.

Piston Valve Cylinder Mold.

"The piston-valve cylinder shown in Fig. 2 has two joints in the mold. The mold is rammed up as previously stated except that a number of loose irons and lifters are required in the drag half of the mold to support and strengthen the pockets of sand, which are left when the pattern is withdrawn. The first joint of the mold is made in the center of the piston valve and the second at the center of the cylinder barrel. The cheek and cope parts of the mold are rammed up the same as for the twin cylinder. In Fig. 8 are shown a set of cores which, when assembled, form one piston valve core. These are put together on horses, the two halves of the valve being joined together after the grooves, which were cut in the cores when green, have been cleared to permit of the escape of the gases. These two half cores are bolted together at the end.

"The steam port cores, which are made in two halves, are fitted into the core prints in the valve core and are tied with wire at the bottom and at the top. After the cores are assembled they are lifted by means of a rope sling. These slings are used as they reduce to a minimum the danger of slipping, and furthermore, rope is more pliable than chain and will handle cores to better advantage. In Fig. 9 is shown one of these cores, which has been put together on the horses, as it is being lowered into the mold. The second core, which has been similarly made and assembled, is shown in Fig. 10. This is placed in the mold at the side of the first core, the exhaust section and that part where the main steam pipe rests coming back to back when these two cores are placed in position in the mold. The cheek of the mold is then placed over the drag, the barrel cores are then placed in their prints, and the cores which are made for the side of the mold are placed in their prints and are held back by means of screws.

"In Fig. 11 is shown the cope half of the mold with the steam pipe cores, exhaust core and one of the side cores. The steam pipe core is made in two halves. The two halves of this core are fitted into their prints in the cope section of the mold, and are bolted together where they meet at the bottom. The exhaust core is also fitted into the core print in the cope and is fastened by means of a screw. The steam pipe core is then temporarily held at the side of the mold and the cope is rolled over. The packing holding this core temporarily in position is then taken out, the cope is lowered over the cheek, clamped together and placed in the mold-drying oven until the next day, when the runners and risers are placed in position.

High-Pressure Cylinder.

"The high-pressure cylinder is molded with two joints in the mold, the first joint being at the center of the valve chest and the second at the center of the cylinder barrel. A view of the finished casting is shown in Fig. 3, in the same position in which it is

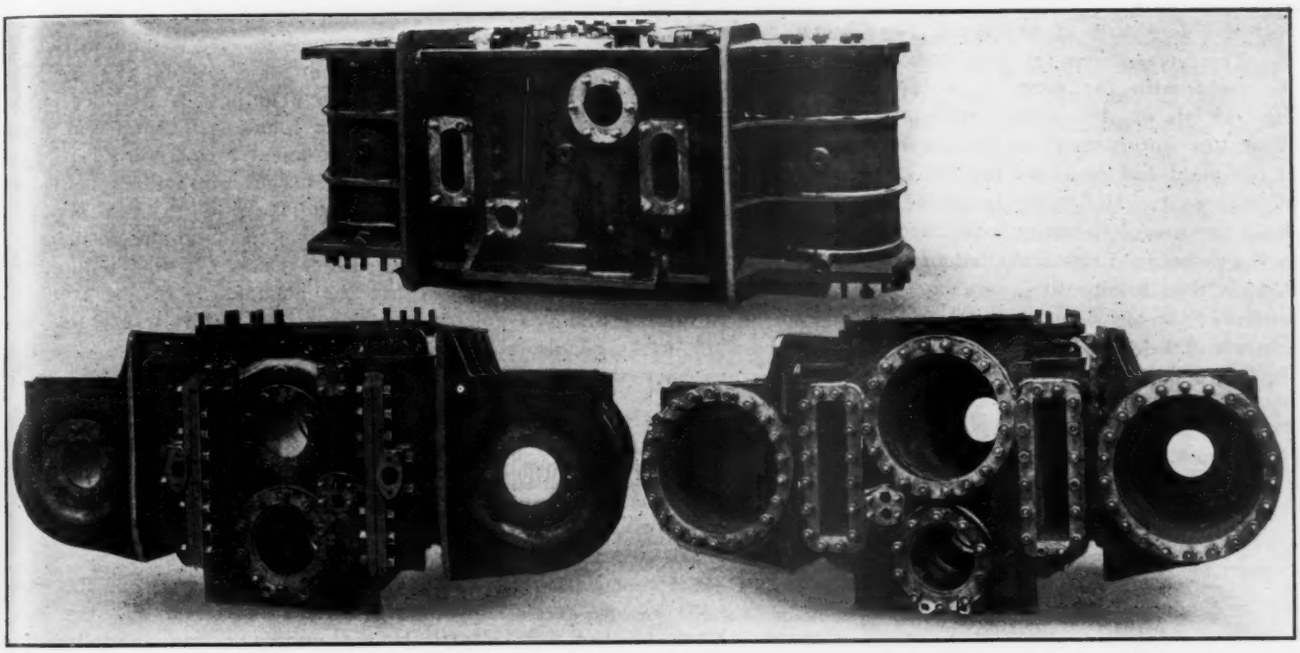


FIG. 15—COMPOUND CYLINDER, SHOWING LOW-PRESSURE CYLINDER BOLTED TO THE SIDE OF THE HIGH-PRESSURE CYLINDER

FIG. 16—FRONT VIEW OF CYLINDER IN THE POSITION IN WHICH IT IS PLACED IN THE LOCOMOTIVE

FIG. 17—BACK VIEW OF COMPOUND LOCOMOTIVE CYLINDER

cast. In Fig. 12 is shown a set of core boxes and core irons, as well as the core as it is assembled ready to be placed in the mold. It will be noted that the core irons for the valve core are not exactly alike, the one at the left having three flanges. These flanges are where the steam pipe rests and the other core is placed in the core box at the right. The cores made in these boxes are assembled on horses. After the usual provision for venting, the two halves of the valve chest core are bolted together at the ends. Then the four halves of the port cores are fitted into the prints provided in the valve chest for that purpose. These cores are tied together at the bottom as well as at the top, and after being assembled are lowered into the drag half of the mold, Fig. 13. This view shows the drag half of the mold with the core in position. Fig. 14 shows the cheek with the steam pipe core, two cores for the side of the mold and one core for the end of the mold. The latter is made to avoid the use of so many loose pieces in the pattern. The cheek half of the mold is then lowered on the drag and the cores for the sides are set in their prints and held back as usual. Then the barrel cores and the steam pipe cores are set in place. The steam pipe core is fitted onto the two projecting lugs of the valve core and the barrel core and the steam pipe core are spaced apart by means of a nut. Wire is fastened to this nut, and is passed through the space and is temporarily fastened to the top of the core. As the cope part of the mold is lowered onto the cheek, a molder places his hand through the hole in the loam cake core and draws up the nut which has been used to temporarily hold the steam pipe core in place. This core is weighted down at one end and a chaplet used at the other. The mold is then dried as previously stated. Three views of the compound cylinder are shown in Figs. 15, 16 and 17. Fig. 15 shows the low pressure cylinder bolted to the side of the high pressure cylinder. This is a top view. Fig. 17 is a back view of the cylinder and Fig. 16 is a front view of the cylinder in the position in which it is placed on the locomotive.

Metal Mixture.

"The metal used for the cylinders consists of 2,000 pounds of hard iron and 1,000 pounds of soft iron. This charge constitutes the first 3,000 pounds of iron melted in the cupola, and the other charges have the same proportion of hard and soft iron. We find that a mixture of the following analysis serves our purpose:

	Percent.
Graphitic carbon	2.7
Combined carbon	0.8
Silicon	1.2
Sulphur, not over	0.08
Phosphorus, not over	0.45
Manganese	0.8

"These castings will give good transverse test results. The metal should be cast very hot and the castings are left in the molds to cool about 20 hours."

In the discussion of Mr. Pemberton's paper, it was pointed out that the use of new sand entirely for facing was rather remarkable, inasmuch as it was believed that a certain proportion of old sand would serve the purpose. Mr. Pemberton, in reply, said that old sand was used in the facing mixture for green sand work. An allowance for finishing the cylinders of ⅜ to 3/16 inch is provided, which has been found sufficient. Tin plates in the runners are preferred to loam stoppers. The contraction of the cylinders ordinarily is ⅛ inch per foot. The loam allowed on the core bars is 1¼ inches thick. It was pointed out that the phosphorus in the iron was somewhat low, but it was stated that this iron could be furnished by a number of English blast furnaces.

A Discussion of Foundry Efficiency*

By B. D. Fuller

THE question of raising the efficiency of the shop is ever a live one, be it in the machine, pattern, smith, boiler shop or foundry. Hence, I feel it will not be trespassing upon the time of this body to ask you to devote a few minutes to the consideration of methods which have been tried, and, so far, proven successful. First, consider the problems of excess weight on castings due to careless ramming, weak flasks and loose bars, weak boards, soft pit walls, etc., and what do they mean? Not only a poor casting but an expensive one in many ways. If it be a small casting, say one properly weighing 5 pounds, and the order calls for the delivery of 1,000 daily, you produce 1,000 castings which, due to some negligence, average 5½ pounds. The day's work shows 500 pounds excess weight at $0.008 per pound, which equals $4.00 per day for the one pattern in iron cost only. While the foundry will probably receive credit for the extra weight, it means a loss however to the concern which charges a certain figure for the finished equipment.

*Presented at the Detroit Convention of the American Foundrymen's Association.

Losses in the Machine Shop.

Another loss is in the machining, as jigs will not fit properly, and when your foundries are in one city, and your machine shops in another, there is the extra freight charge from foundry to factory, and again the extra freight charge when shipping the finished equipment. If the casting is a heavy one, such as an engine, or generator bed, armature spider, field frame, etc., something weighing 15 to 40 tons, the case is more marked. A variance of 1,000 pounds or more, in two castings from the same pattern is not extraordinary. This, when the freight shipments are thousands of tons monthly, means a heavy loss.

Awaken a live interest in this question in your foreman, and the result is not only a saving in dollars and cents, but the satisfaction of noting a marked improvement in the quality of output. In our case, a card record of shipments by pattern number is kept, upon which card weights are recorded as separate shipments are made. Gains or losses are tabulated in a monthly report which is totaled at the close of the month, each foreman's department being segregated.

Surplus Weight of Castings.

Many disagreeable surprises are in store for any one compiling such a report, but when the foremen are gathered to discuss the question, and marked cases are brought to their attention it "sinks in" with the result that, as in our case, it shows a decided total gain. Following up this matter has also emphasized the advantage of the molding machine, as invariably the transfer from hand to machine molding shows a decided gain in quality as well as reduction in weight. This may not appeal

to the man who sells his castings by weight, but it will appeal to his customer from both standpoints.

In the machine shop the removal of surplus stock is an item of expense which is receiving more attention than it has been accorded in the past, and a close communion between machining and casting departments will produce results which are at times surprising. A certain line of motor castings produced in large numbers in the foundry with which I am connected have recently been the subject of a considerable exchange of comment and suggestion as to ways and means of reducing the amount of labor in finishing. A large gang of chippers is employed in the foundry on this line of castings, as well as in the machine shop before the work passes critical inspection.

A method of pattern construction was devised which so simplified the molding as to produce castings which, on an average, require one and one-half hours less chipping per piece, effecting a saving of the labor of five or six men per day. The saving in weight is not so marked, but it is still enough to be a factor. The great difference is noted in the machine shop, where the labor saved in finishing is considerable.

A striving to improve a record among the foremen must needs awaken an ambition among the men, and nothing is better for the shop than to get the men interested in a contest of this kind.

Efficiency Record.

Another method now employed, and which promises well, is an efficiency record, whereby a report is tabulated daily, showing the amount cast in pounds by each man of good and bad castings, the percentage of scrap made in each department or bay, in a given period, usually from one bay to another, and which shows whether a man is over or under the average of his bay for this period.

Individual Records.

A foreman's record is determined by the average of all the men working in his department. This individual record is kept by card index, so that any man may be shown his record at any time, and the deserving can be singled out. This card record is of considerable value especially, when men ask for advances in wages from time to time. The comparative value of any employe may be instantly determined, and if a man's record shows that he has made more scrap than the average of his department, not much time is wasted in argument.

Copies of a tabulated report are daily handed to each foreman showing the number of castings made from each pattern, and the number which were defective. These are in parallel columns for easy comparison.

A record of the coremakers' output is also maintained and opportunities are afforded the ambitious for advancement. This system is also applied to the yard labor, such as loading and unloading cars, piling and transporting stock, iron scrap, coal, sand, limestone, clay, etc. If a record is kept whereby each operation has been segregated as to cost, it is an easy matter to strike an average as to the cost of the whole, using as a base the average cost per ton at present, or the best figure recorded. Offer the man in charge of the whole yard force a premium for every fraction of a cent per ton he can reduce this record price. Do the same with the cupola operator. The same system can be applied to the man responsible for the cleaning and chipping of the castings, and you will be surprised at the results. However, do not make moves which will weaken the men's confidence in your fairness.

Silicon and Hardness

By W. J. Keep

Question:—What should be the silicon content of an iron for producing pulley rims? When a satisfactory mixture is obtained, at what speed should a soft iron pulley be turned in the machine shop? Will the use of too much silvery pig iron make the iron weak or brittle? With a soft mixture, what would be the strength of a test bar, ½-inch square and 12 inches between supports? Some of the different grades of iron we use in our mixture follow: Silvery iron, 6.50 per cent silicon, No. 2 foundry, 2.50 to 2.80 per cent silicon; Lake Superior charcoal, 2.22 per cent silicon. How can we ascertain whether our mixture is correct without being compelled to depend on the machine shop for information regarding hard castings?

Answer:—The percentage of silicon required depends upon the thickness of the rims. The thinner the rim the higher the percentage of silicon, and the average should be about 2.75 per cent. In the machine shop, the speed with light tools was about 40 feet per minute, but with the new high speed steels, this speed can be greatly increased. It makes no difference how you get the silicon into your mixture, whether by a silvery iron or by using a pig iron with the required silicon. Softness will increase until the silicon reaches 3 to 3.50 per cent. For light castings, such as pulley rims, the iron will not become brittle until 3 per cent is reached, but heavy arms, cooling more slowly, might be weak. High silicon makes all castings soft, and small castings strong, but large castings containing such a high percentage of silicon will be weak. Low silicon produces hard castings, renders small castings brittle and perhaps weak, and makes large castings strong. The percentage of silicon does not always vary as the strength, therefore it might be advisable to experiment until a strong mixture is obtained, whether the castings are to be hard or soft. The strength of a ½-inch test bar, 12 inches long, should never be less than 400 and should be 450 pounds.

The only way that you can determine the quality of your iron without a report from the machine shop is to test your mixture for strength, and we suggest mechanical analysis to regulate the proper percentage of silicon. On the other hand, you can also employ a chemist instead of resorting to mechanical analysis.

Notes on the Melting of Iron in Cupolas

By A. J. Ehrob

THE first form into which iron is generally produced from the ore, is what is commercially known as pig iron. Its principal constituents, aside from the pure iron, are carbon and silicon. Manganese, sulphur or phosphorus are not essential, although they contribute their quota to the various qualities of this blast furnace product. When an iron mixture is remelted in a cupola, it loses a part of its carbon, silicon and manganese. In ordinary practice, the loss is not above 15 per cent of the total amount of silicon and 20 to 30 per cent of manganese. These losses are provided for in the mixture. The replenishing of the carbon, as a rule, is not figured on, and is allowed to take care of itself. The losses are caused by oxidation. We will call the oxidation normal when it is kept within the limits mentioned, and abnormal when it exceeds these limits.

In the cupola, when everything is running right, and no strong oxidation takes place, there exist two dis-

tinctly separated zones. One is the combustion zone and the other is the melting zone. The former is located in front of the tuyeres where the entering air plays on the coke and it may extend slightly upwards. The melting zone is located above the zone of combustion and at a point in the cupola where the temperature is high enough to melt iron. Between these two zones there should always exist a layer of coke, which we will call the protective layer. This layer should be heavy enough to reduce part of the carbon oxide, which has formed in the combustion zone, to carbon monoxide. If through any of the causes, which will be mentioned later, the two zones have been disturbed in their relative positions, so that a part or the whole melting zone has been lowered, an abnormal oxidation will follow.

Oxidation.

During an extended heat the tuyeres always scaffold with slag, due to its solidifying when it comes in contact with the cold air entering tthe tuyeres. The scaffolding offers resistance to the blast, and will affect the amount of air flowing through the tuyers. It should be noted that carbon dioxide at a high temperature will burn coke, and will also oxidize iron as well as its silicon, carbon and manganese content.

When the protective layer of coke is high so that the gases which go through it come in contact with large quantities of hot coke, a large part of the carbon dioxide formed in the combustion zone will be reduced to carbon monoxide, and if carbon monoxide prevails sufficiently the gases may be of a reducing influence at the temperature prevailing in the melting zone and the iron may come softer than normal and the flame will be blue in color.

If the protective layer of coke is thin all over the cupola, the gases from the combustion zone will carry more carbon dioxide and less carbon monoxide when reaching the melting zone, and the gas will be of a more oxidizing nature than normal. An excessive quantity of the iron itself may be oxidized, throwing off brown fumes, and the whole flame will turn a rusty brown, both manganese and silicon will be carried into the slag, and an extra hard iron will be the result.

Normal Oxidation.

When the protective layer of coke is of right height, the mixture of carbon dioxide and carbon monoxide is neutral. The flame at the charging doors will be blue to faint violet in color, and the iron will suffer a normal oxidation only. The normal oxidation takes place when the iron in its molten state drips through the combustion zone. It will vary inside the limits given, when the combustion zone varies in height, and this will depend upon the flow of air admitted to the cupola as well as on the quality of fuel. When the flow of air is increased more coke will be exposed to combustion, consequently the combustion zone will be increased.

When the coke is coarse, there will be less surface in the same space for the air to attack than when the coke is fine. A hard coke will not burn so quickly as a soft coke, hence more of it will be exposed to the air than when soft coke is used. The result will, in both cases, be an extended combustion zone.

Clogging of Tuyeres.

If only a part of the protective layer of coke has become thinner than normal, the oxidation may cause a local disturbance in that the slag formed, which is highly charged with oxide of iron and lime, will cut away the scaffolding in front of a tuyere. The flow of air through such tuyere will be stronger than through any other, due to the fact that the air pressure remains the same at all points, but the available opening is larger at the clear tuyere than at the others. The fuel will burn faster here than elsewhere, and faster than the melting will take place in other parts of the cupola.

As the gases which are formed in the combustion zone strive to fill the cupola uniformly, the material which comes down over the open tuyere will not get its full quota of preheating, consequently the bed will be lower over this tuyere and the melting zone will come still nearer to the combustion zone, air will play on the melting iron and cause considerable loss. If the remedy has not been applied in time, an aggravated condition will exist, which can be corrected only by an extra addition of coke for some few consecutive charges, until the low place in the bed has been raised high enough, and the tuyere again, through scaffolding of slag, admits a normal flow of air. In addition to coke, it might also be advisable to charge the silicious material over the weak spot and also omit the lime at this point.

When the condition just described exists, whatever may have brought it about, the otherwise blue or light violet flame will show a brown fringe of oxide of iron, and the iron will come harder than the mixture was calculated to run.

If a cupola runs normal with a certain amount of coke per charge and with a certain flow of air, increased oxidation will follow an increase of blast pressure. When the flow of air increases, the combustion zone will be extended upward, due to the fact that an increase of air will cause an increased surface contact between the air and the coke; hence more coke must be exposed to the direct contact of the air, and as this can take place only in the upward direction, the protective layer will be thinner. In addition the gases of combustion will travel faster and get less contact with the coke before reaching the melting zone, more carbon dioxide will be present when they come in contact with the melting iron, and greater oxidation will result.

If the blast is reduced, the flow of air will decrease in volume, and the protective layer will in this way be relatively increased above the tuyeres. The complete combustion may also decrease in the part of the combustion zone which is nearest the tuyeres, and the inner part of the bed coke will be consumed by carbon dioxide, and thus act as an addition to the protective layer of coke. The result will be less than normal oxidation in the center part of the cupola. The iron will, therefore, come softer than normal, but normal if an excessive oxidation has been prevalent before the decrease of blast.

If the quantity of coke is reduced and the flow of air maintained as before, the layer of protective coke will naturally be thinner, due to direct decrease in the quantity used and the same result as mentioned will follow.

If the amount of coke is increased and the air flow in this case also maintained unchanged, less oxidation will be the result, due to the increased protective layer of coke.

The lowering of the charges in the cupola or delay in entering the charges, will cause increased oxidation. The column of resistance has by this change been decreased, and hence more access of air will be the result. The same condition will exist as in the case of an increase of pressure. The effect will be small unless there has been a great delay in charging; however, it will be a move in the direction of abnormal oxidation.

Open Charging.

Coarse material and open charging will permit a greater amount of air to enter the cupola than small material and compact charging, due again to less resistance in the former case compared with the latter. Open charging on one side and close or compact charging on another will cause an uneven bed. In this case, although the air may enter uniformly through all tuyeres, the gases will deliver the heat in the direc-

tion of the escape, and this will of course be in the direction of least resistance, or to the side where the loose charging has been done. The compactly charged part will not be as well preheated as the loose part, hence the material will not as soon reach the melting temperature, and will come lower down before it melts. On the other hand, the bed on the loose side will be raised, on account of the material at this point being preheated to a greater extent, and will reach the melting temperature higher up in the cupola than when the charging is uniform, and the gases preheat the material uniformly. Uneven charging, with more iron placed on one side than on the other, will rob that part of the cupola of its share of coke where most iron is placed.

If we charge material which will melt at different temperatures, an extended melting zone will likely result. The iron part of the charge will melt at a lower temperature, and, therefore, higher in the cupola, while such material which requires a higher heat will melt last and nearer the tuyeres.

If an excess of coke is not used so as to raise the heat sufficiently over the tuyeres, this last mentioned material will come down in front of the tuyeres, and be exposed to the strongly oxidizing gases in the combustion zone and oxide of iron will be formed which will produce a corrosive slag. This material may even penetrate the bed and come down unmelted into the hearth. Note that this may only occur if sufficient coke has not been used, and when the material which is charged melts with difficulty, such as wrought iron or soft steel.

Leaving the slag hole open for a long time will draw the heat in that direction by allowing part of the gases formed in that section of the cupola to escape through the slag hole, especially if it is large and will deprive the material above of the heat that otherwise would be given to it. The material above the slag hole will, therefore, be less preheated than the rest and consequently reach its melting temperature lower in the cupola; that means the bed will be depressed in this region and abnormal oxidation will follow, which will have a tendency to keep the tuyeres near the slag hole more open than the others. In cupolas where this condition is allowed to prevail, a brown or yellow flame will show over the slag hole.

It frequently happens that a cupola will run erratic, and oxidize when the slag has for a time been quite thick, due to insufficient flux.

This I have noted to be the case when the scaffolding, apparently alike at all tuyeres, has taken such proportions as to act like a large sponge for the penetrating air, throwing the same in all directions, up as well as down. In other words, the air has no straight course into the bed coke, but will enter both above the tuyeres and in front of them, and may even enter the melting zone, especially if the scaffolding has been high. Oxidation will follow and a part of the scaffold, generally the upper part, will be cut away by the oxide of iron formed and the air will get a chance to flow freer and enter the bed too high, increasing the evil. A fairly thin slag is undoubtedly the best. It has, in my experience, given the best heats. The air will, under similar circumstances, enter all tuyeres fairly uniformly. The addition of lime will regulate the fluidity of the slag, even when no oxidation takes place, and if the material used varies considerably in silica, so should also the addition of lime vary during the heat.

This means that when more silicious matter is present in one charge than in another, or when the coke carries more ash in one charge than another, lime should be used in proportion to the amount of material present, which needs fluxing. Fluor spar may be used to advantage, inasmuch as it will flux the silicious matter and also the lime that may have been added in excess, when the silicious matter in the charge decreases and the lime addition is a constant quantity. Thus it will regulate the fluidity of the slag continuously.

Excessive Flux.

An excessive amount of flux will produce a slag, which will absorb the silicon from the iron in the hearth, and cause hard iron. If an insufficient amount of flux is charged, the iron may reduce silicon from the strongly silicious slag in the hearth, and as this may occur irregularly, we may have an erratic heat with iron, which runs normal and again softer than intended.

When we are using a very solid, coarse coke, more carbon dioxide is produced than with the use of soft coke, as the carbon dioxide formed in the combustion zone is not, by its contact with the hard coke, readily converted into carbon monoxide when passing through the protective layer of coke; hence the gases carry a larger amount of carbon dioxide when they reach the melting zone, where a part of the silicon and manganese in the charge will be oxidized.

The charges should be as small as possible. When an iron charge reaches the melting zone, the coke in the bed will continue to decrease through combustion and, consequently, the protective layer grows thinner until the next charge of coke has replaced the part of the bed that has been consumed. The consequence will be that the first part of an iron charge will melt over a full protective layer of coke, while the last part will have a small protection, and if the charges are heavy no protection at all.

If the charges are small, these unavoidable fluctuations in the height of the bed will be reduced to a minimum. From this it may well be understood that iron, not uniform in quality, may be tapped from a cupola running with heavy charges, even if everything else is well regulated and normal.

Moist Air.

It is well known that moist air will oxidize iron quicker and stronger than dry air. At high temperatures, this condition will be still greater and hence we can expect a greater oxidation when the air is heavily charged with humidity. Air accompanied with vapor into the cupola will, at the high temperature there prevalent, cause stronger oxidation than if the air entered dry, and, as the humidity may vary during a heat, so will also the oxidizing influence vary. The lowering of the temperature in the cupola, due to the cooling effect of moisture, may result in greater oxidation.

Indications which point to abnormal oxidation, besides the hardening of the iron, are first of all the flame at the charging doors, and next the slag. If the gas above the charges does not burn, there is smoke, which may give a slight indication of normal or abnormal oxidation. Carbon monoxide burns with a blue flame and the other colors which may appear are given to it by fumes of oxide of iron. In the beginning of the heat, steam caused by dampness in cupola walls may cause a yellow color. The different shades given to the flame in connection with the abnormal oxidation can only be learned by experience and close observation. It may be sufficient to say that the flame at the charging doors will vary in color from blue to violet to a rusty brown.

In the report of the proceedings of the annual convention of the American Brass Founders' Association published in THE FOUNDRY, July, 1910, page 260, the statement credited to C. P. Karr that he was using 7½ pounds of coke to melt 1 pound of bronze should have read "That he was using 1 pound of coke to melt 7½ pounds of bronze."

MOLDING A MARINE ENGINE BED PLATE

Method of constructing the pattern and core boxes, making and setting the cores and finishing the mold

By Joseph Horner

FIGS. 1 and 2 illustrate the middle or main bed plate casting for an engine bed for small triple cylinder marine engines of stock dimensions, of which a large number have been made. There are six bearings for the crank shaft, two of which are contained in each casting. The wing beds, not illustrated, differ but slightly from the one shown in Fig. 1, but the illustration of the methods of molding, apply also to the others. A few over-all dimensions are given for the one in the illustration, so that an idea can be had of the size of the job.

These castings are molded face down, which renders necessary the hanging of those cores in the top which cut through the bottom of the bed plate castings as they lie in place.

The work, therefore, lies much more in the cores than in the mold. As the mold is quite clear and open on the delivery of the pattern, the various bracketings next to the bolting flanges can be left loose, and easily drawn in horizontally.

The Pattern.

The pattern is illustrated in Fig. 3. Little explanation is necessary as the various sections are timber shaded. Details of construction might be modified in the hands of different men, but that is of no consequence. The essential thing is the boxing up. The top *A* and bottom *B* are both framed together with half lap joints, as seen at the left of Fig. 3. These are screwed to the vertical pieces, which form the pattern sides. These pieces are put together to give the necessary taper on their outside faces.

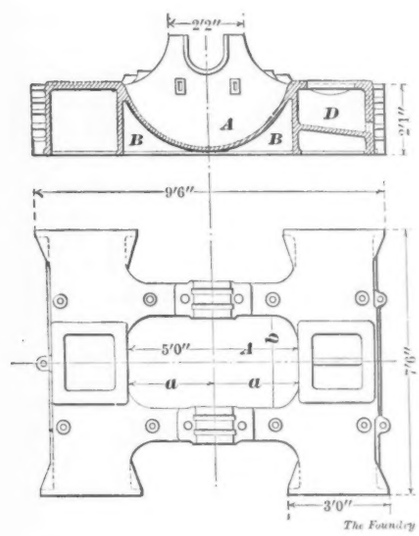


FIG. 1—SECTIONAL ELEVATION AND PLAN VIEW OF SMALL TRIPLE-CYLINDER MARINE ENGINE BED

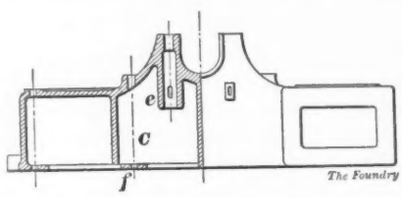


FIG. 2—SECTIONAL VIEW OF ENGINE BED

The strongest method is that shown at *C*, namely, by notching and locking, the notches being cut down to the center of each piece. End pieces *D* are fitted between the uprights at the joint ends, and flange pieces *a a* are screwed on the outside in continuation of these. The corner brackets at the sides are screwed on in the top, wired on below. Large radii are given the angles as seen at *b* in the plan view. They may be screwed or not.

Construction of the Pattern.

On this boxed-up bed sundry parts are fitted. The crank shaft bearings *E* are too large to be cut out of the solid. They are built up of two sides with blocking fitted between, after the fashion shown at the right hand of the upper part of Fig. 3, or with segments cut to approximate curves. The bearing core delivers itself very well. The facing *C C* for the brasses are wired on as shown. Two round prints are nailed on for the cap bolt holes.

Two facings for the A frames are fastened on as shown, with their core prints, as well as bosses for holddown bolts. The central area, which will form the crank recess, and the metal beneath it, Fig. 1, is now filled in. It is boarded across on top and bottom with strips, *F*, having open joints, resting on corner blocks and strips, indicated by the dotted lines below the boards. The pieces *F* may be battened together on the interior faces, or laid in loosely as shown, which is quite sufficient. On the upper face the strips *F* form the print for the crank recess and on the opposite face they come flush with the back of the pattern.

On the back or top, prints are screwed for the main cores, as seen in the upper part of Fig. 3, the positions of which in plan are identical with those of the cores in Fig. 12. Planing strips are attached to the four joint faces as shown.

The Mold.

The mold is of course made by bedding-in the pattern, on account of its size. A cinder bed is laid down all over the area which the mold is to occupy, and the pattern is leveled and rammed with its back or top face flush with the foundry floor. A plain top, set with stakes, covers it. This will be understood without illustration. As the main bearings deliver themselves in the bottom, we will give our attention to the cores.

The Cores.

The only large core in the bottom is that which takes out the recess, *A*, in Fig. 1, for the crank, and for which a print, *F*, has been put on the lower face of the pattern, Fig. 3. The reason for coring in preference

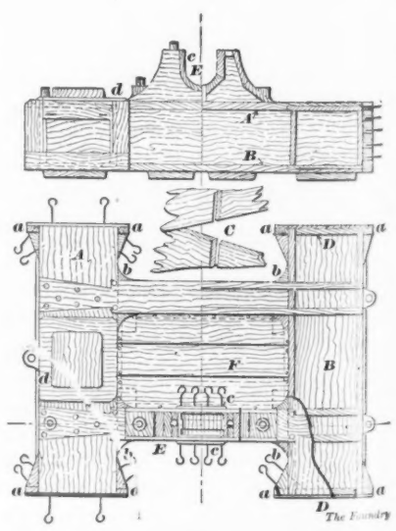


FIG. 3—PATTERN FOR ENGINE BED PLATE

to cutting this out is that coring simplifies the pattern work, and leaves a much stronger pattern than cutting out would do. As the length of *A* measures 5 feet in this case, the core is conveniently made in halves, abutted at the central plane of the bearings.

Core Box.

Fig. 4 shows the core box for these cores, and Fig. 5 a core rammed on its grid, standing in the position which it is to occupy in the mold, being so rammed to avoid turning it over. The skeleton framing of the box should be noted, the curve of the cores being strickled by the edges of the box. The width and length of the core box are lettered to show the correspondence with these dimensions in Fig. 1. The grid, seen outlined in plan and section in Fig. 5, is made of cast iron, with three eyes cast in for lifting and dropping in the mold, and with rods to support the sand. All of the central portion of the core is composed of cinders to receive the air which finds exit through a central hole into the bottom. The large radii, taken off the corners of the curves, shown in the plan view of the casting, are rubbed to a templet supplied by the patternmaker.

Setting the Cores.

The cores for lightening out the spaces, *B B*, beneath *A*, Fig. 1, but above in the mold, are rammed in the box, Fig. 6. These have to be turned over to go in place, so that

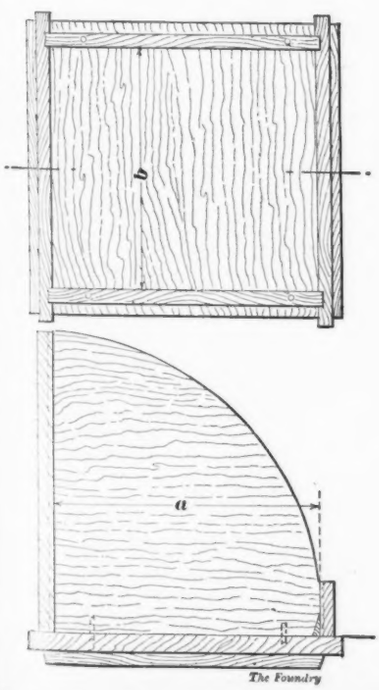


FIG. 4—CORE BOX FOR ENGINE BED PLATE

eyes are not used in the grid for lowering them. Nuts are cast in these grids, Fig. 7, to be used for fastening these cores in the top. The rods are bent at the ends to support the sand. Partial support and steadiness is also

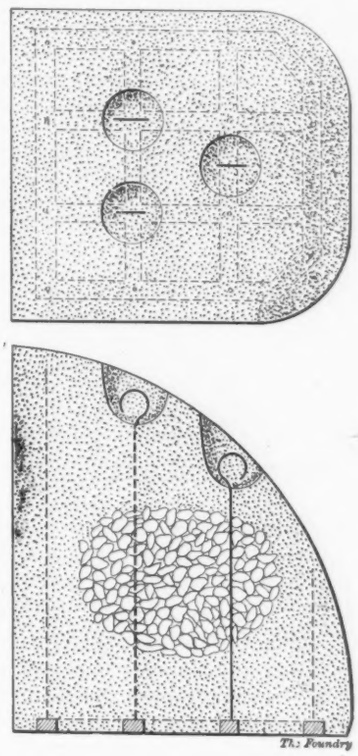


FIG. 5—CORE FOR ENGINE BED PLATE RAMMED UP ON A GRID

afforded by chaplets set between the cores for the spaces *A* and *B*, by which the correct thickness is also insured.

The cores for *C*, Fig. 2, which come underneath the bearing, include the bosses for the cap bolts of the main bearings, and a bridge of metal which guides the hold-down bolts adjacent. The cores are rammed in a box, Fig. 8, using a grid as shown in Fig. 9, having rods cast in and standing out and bent on each side to carry the sand. These cores are carried in prints in the top of the mold. They abut at one place, *g*, and are shouldered back to leave a rib of metal between them, seen in half thickness in Fig. 2.

The cap bolt holes with cotter ways, Fig. 2, are made from the box in Fig. 10. The cores are each supported in a bottom print impression, and are steadied sideways in the upper part of their boss with chaplets. The cotter way is a portion of the core, being rammed with it, a part in the bottom board, and the part in the opposite side in a loose piece dowelled on the top edges of the box.

There are now several nearly plain cores required to complete the job, which need not be all illustrated. They are seen in the plan of the cored mold in Fig. 12, and their shapes are indicated in the views of the casting. They are nearly all carried in print impressions in the top, the exception being the cores, *D*, Fig. 1, which fit a print in the bottom. All are rammed on grids, the plates of which go in the lower portion of the core, the eyes, except in the case of *D*, standing up to be secured in the top. It is not necessary to show the boxes for these plain rectangular cores. A box, Fig. 11, is shown, which takes out a moiety of the metal beneath one of the facings for an A-frame. A comparison of it with the castings will show its relationship.

Binding the Cores.

Although these cores are mostly fastened in the top, it would not do to trust to that alone. Yet the job is too heavy to risk the turning over of the cores with the top bodily. They are therefore all laid in place in the bottom of the mold, Fig. 12, resting on stout chaplets, which are nails knocked down to the thickness by means of a gage. The vertical spaces between the cores are tried with gage strips. Some slight rubbing of the cores may have to be done to get the thicknesses alike. A straight-edge is also tried across the tops of the cores to see if they are all level. When all is right, the top is lowered gently on the cores and lifted again to see if there is any crush of core prints, or cores, and correction made where found necessary. Then

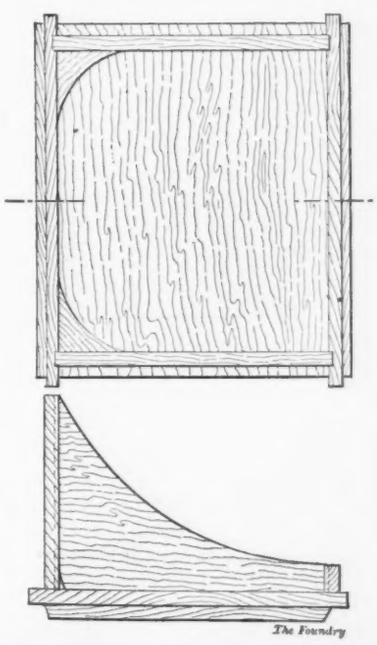


FIG. 6—CORE BOX FOR LIGHTENING CORES

the top is lowered to a close bedding and the fastenings of the cores made good with bolts, taking care to secure the vents into the top with rings of encircling sand. The top is lifted clear of the mold and swung around out of the way, but not turned over. Any sand that has tumbled down is cleared out, and the top, after examination from below, replaced ready for pouring. The metal is run in from each end, passing directly into the ribs between the cores.

Strength of Nickel and Copper with Electrolytic Iron

BASED upon the discovery of a simple method of refining iron electrolytically, an extensive line of laboratory investigations was begun five years ago in the Applied Elecro-chemistry Laboratory of the University of Wisconsin, Madison, Wis., and has been carried on almost without interruption since that time. The investigations have consisted of the production and study of the properties of alloys of iron, eliminating as far as possible the common impurities, sulphur, phosphorous, silicon, manganese and carbon. The results of the experiments, conducted by Charles Frederick Burgess and James Aston, are published in a recent number of the *Bulletin* of the University of Wisconsin.

The basis of the alloy dealt with

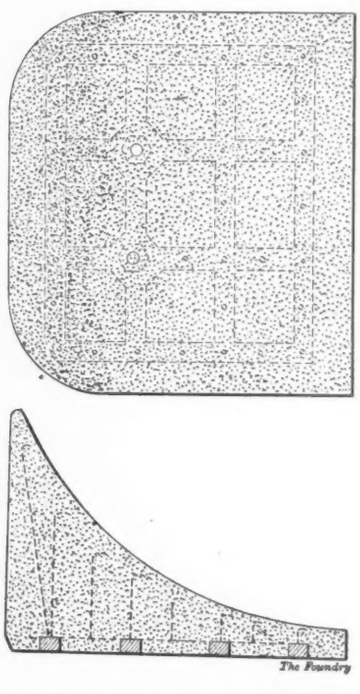


FIG. 7—LIGHTENING CORE, SHOWING GRID AND SAND SUPPORTS

was iron of a high degree of purity, obtained by double electro-deposition. In the first refining, high grade Swedish bar iron was used as anode material, and the metal was deposited upon both sides of a sheet lead cathode.

These cathodes were then used as anodes in a second set of tanks and

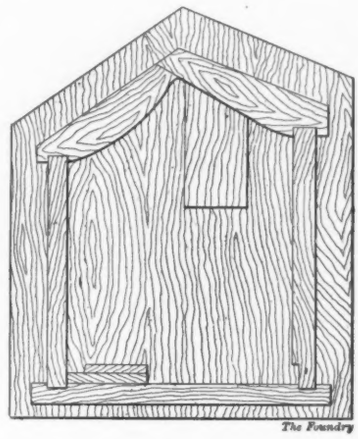


FIG. 8—ANOTHER CORE BOX FOR ENGINE BED PLATE

a double refined product obtained upon a sheet aluminum cathode. This electrolytic iron was stripped off in sheets ¼ inch to ⅜ inch in thickness, and about 10 inches square, which was broken for use in crucibles. In the preparation of the alloys, the predetermined amounts needed for each charge, together with the additional elements, were weighed and were melted in specially prepared magnesia crucibles, which were protected by a graphite jacket, and buried in an electric furnace of the resistor type. The charge was prevented from contamination by a magnesia lid luted on the crucible, and a graphite cover for the jacket.

The charges were brought to fusion and held at this temperature a few hours, after which the current was cut off and the furnace allowed to cool. The charge was not agitated, the resulting alloy being entirely due to diffusion of the elements. The ingots weighed about 500 grams or 1 pound.

Absorption of Impurities.

In spite of all precautions, there was some absorption by the charge. There is every indication that this was due to the interaction between the iron and the carbon monoxide furnace atmosphere, whereby carbon was set free by the reaction. Numerous analyses showed the amount to be well under 0.10 per cent. Sulphur, silicon, phosphorus and manganese are negligible. A charge of electrolytic iron melted into an ingot and forged showed by analysis, carbon 0.047, sulphur 0.005, silicon 0.062, phosphorous 0.016, but no trace of manganese.

The ingots were heated in a forge fire and drawn out under a steam hammer into rods about ½ inch in diameter and 20 inches long. These rods were cut into appropriate lengths and machined for the tensile strength tests into bars approximately 0.3 to 0.4 inches in diameter over a length of two inches. The tests were made upon a Riehle, 1,000,000-pound power-driven machine. The load was applied very slowly, and the elastic limit or yield point was determined by means of dividers, being taken at the point at which a perceptible stretch occurred in a marked 2-inch length of the bar.

Addition of Nickel.

In this research the effort was to determine the effect of adding varying percentages of nickel to iron in the absence of the other impurities, especially carbon. The added nickel was electrolytic material of high grade. The ingots tested were prepared of all compositions from zero to 100 per cent of nickel. The ingots were sound and the lower percentages forged about the same as iron at normal temperatures. There was no trouble in forging any of the alloys within the range of zero to 20 per cent of nickel. Alloys of 25, 26, 28, 35, 50 and 75 per cent nickel forged without any perceptible difficulty and with extreme care and high welding heats, a good bar was drawn out of an 5 per cent nickel ingot. A high heat

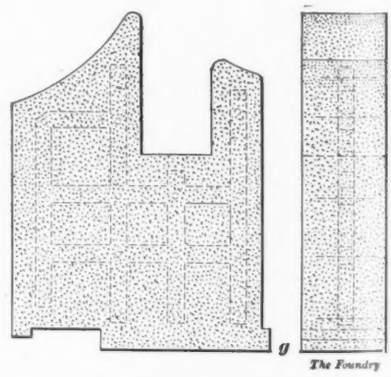


FIG. 9—CORE FOR ENGINE BED PLATE

is probably necessary for all of the high nickel alloys.

There was also no difficulty in welding low nickel bars. During forging, the high nickel alloys, including one of 85 per cent nickel, which tended to crumble at lower heats, welded

nicely at a very high temperature of working and with the liberal use of borax, to prevent oxidation.

As regards hardness, working was easy in the un-annealed condition for alloys up to and including 7 per cent of nickel. From 8 to 10 per cent they were rather stiff, between 11 and 20 per cent hard, with the 20 per cent alloy less hard than some of those of intermediate compositions.

In the bending tests, the bars were sawed half through in the un-annealed condition. Alloys up to 2 per cent nickel cracked at a 60-degree angle; from 3 to 8 per cent nickel they cracked at 45 degrees; from 9 to 10 per cent at 30 degrees, and from 11 to 20 per cent, inclusive, they broke off short. The fracture changed from fibrous to granular at about 10 per cent nickel.

Tensile Strength.

The tensile strength showed that up to 8 per cent nickel there is a gradual increase of ultimate strength and elastic limit; with a nickel content of 0.25 per cent, the ultimate strength was 66,730 pounds, and 57,180 pounds elastic limit. For an increase of nickel up to 8 per cent, these values rose to 91,740 pounds tensile strength and 70,770 pounds elastic limit.

The elongation and reduction of

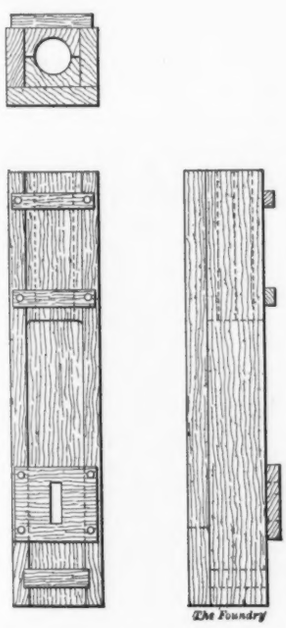


FIG. 10—CAP BOLT HOLE CORE BOX

area indicate a decrease of ductility up to 2 per cent, from this point they rise to a maximum at 5 per cent nickel, above which there is a gradual falling off until 8 per cent of nickel is reached. At 5 per cent nickel the elongation is 29.2 per cent and 65.2 per cent reduction of area.

Beyond 8 per cent nickel the tests indicated a brittle zone, which is most pronounced at 11 per cent nickel, when the tensile strength is 181,230 pounds, elastic limit 148,240 pounds,

FIG. 11—CORE BOX FOR *A* FRAME FACINGS

elongation only 7 per cent, reduction of area 25.5 per cent.

Above 12 per cent ductility returns, and at 20 per cent nickel the tensile strength is 186,000 pounds, elastic limit 115,500 pounds, elongation 16 per cent, reduction of area 59.5 per cent. Above 20 per cent nickel ductility further increases. At 50 per cent the tensile strength is 108,500 pounds, elastic limit 75,700 pounds, elongation 26.5 per cent, and reduction of area 63.77 per cent.

Steel Scrap for Sash Weights

By N. W. Shed

Question:—At the end of every heat we cast about a ton of sash weights, and we would like to use steel scrap, of which we have accumulated about two carloads. Recently, at the end of the last heat, we charged about 1,500 pounds of cast scrap, and mixed with this 500 pounds of steel scrap. We used no flux of any kind. The iron, when tapped, was sluggish and there was a large amount of slag. We would like to know whether we can successfully melt the steel scrap. It would pay us better to run it into sash weights than to ship it to the steel works. Can we melt it alone at the end of the heat, or will it be necessary to mix it with a certain amount of cast scrap? Should we use a flux, and if so, what kind, and how much? What percentage of steel scrap will we lose in melting? Kindly advise us the percentage of loss in melting the following materials in the cupola: Heavy machinery scrap, stove plate, steel scrap and bright steel turnings.

Answer:—Steel scrap can be successfully melted if mixed with cast scrap or pig iron. If the cast scrap is hard it is advisable to use 10 per cent of soft pig iron in the mixture. When melting steel scrap at the end of a heat, increase the coke charge and reduce the size of the charges. When you melted the 1,500 pounds of iron with 500 pounds of scrap, your coke had undoubtedly burned away, but 300 pounds of good, hard coke would have prevented this. It is advisable to use a flux, approximately 75 pounds of limestone to one ton of iron. The loss in melting will be about 7 per cent. Bright steel turnings are not considered good melting stock for a cupola. A small quantity, approximately 200 pounds per charge, can, however, be used. A large amount of steel can be melted with soft pig iron or scrap, and as high as 50 per cent has been melted, but the cupola was run very hot. For most work, 25 per cent of steel is sufficient. Steel scrap is usually charged on the coke, and better results are obtained by running the steel charge first, by putting the steel on the coke bed, and by running the soft iron charge last.

What does it Weigh ?

By F. Webster

IT often happens that a casting is poured too heavy for the capacity of the scales, and yet it is desired to ascertain its weight. There are several different schemes that can be resorted

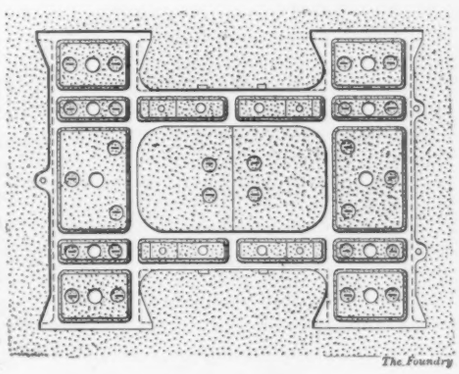


FIG. 12—THE FINISHED MOLD WITH CORES IN POSITION

to for such work, but the one to use will depend upon the form of the casting and the conditions and equipment at hand in the foundry.

One of the simplest cases is where half the weight of the casting can be taken by the scale, as shown in Fig. 1. The casting, *A*, may rest on any convenient form of blocking, B, on the

scale *C*, and the other edge on a block *D*, or be supported by a lever, a jack, or by the crane. Any casting having a symmetrical form can be weighed in this manner.

Weight of an Irregular-shaped Casting.

If it is possible to determine the center of gravity of an irregular-shaped casting, then it can be arranged on the

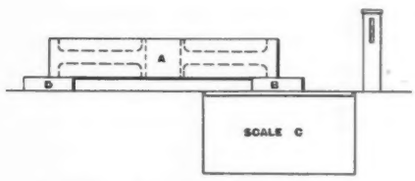


FIG. 1—METHOD OF WEIGHING A SYMMETRICAL CASTING

scale and weighed as readily as though symmetrical. First try and balance the casting on some blunt knife edge, such as a piece of shaft *A*, as shown in Fig. 2. Then mark the longest line across the casting and measure as accurately as possible the length *B* and *C*. Suppose this casting is put on the scale as shown in Fig. 3. The weight on the support at each end can be cal-

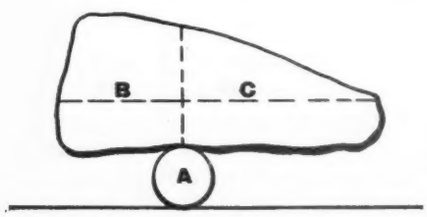


FIG. 2—BALANCING AN IRREGULAR SHAPED CASTING

culated by applying the following principle: The products formed by multiplying each weight by its distance from the center of gravity of the casting are equal. Hence the scale reading, multiplied by the distance, *C*, will equal the weight on the block, D, multiplied by the distance *B*. If B is 3 feet and C 5 feet, and the scale reading 9,000 pounds, then the weight on D =

$$\frac{5 \times 9{,}000}{3} = 15{,}000 \text{ pounds,}$$

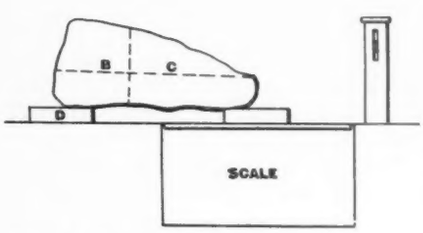


FIG. 3—IRREGULAR SHAPED CASTING ON THE SCALE

and the total weight of the casting = 9,000 and 15,000 = 24,000 pounds.

Weight on Beam Supported by Piers.

Fig. 3 illustrates a very important principle in mechanics which has a great variety of applications. Thus in Fig. 4, a beam 10 feet long spans the opening between two piers. Now if a load of 500 pounds is placed at the middle of this beam one can see at a glance that half of this, or 250 pounds, rests on each support. But if several loads are placed on the beam and at various locations, the pressure at each pier, called the reaction, cannot be determined in such an off-hand way. Hence, the use of a regular system of calculating problems of this kind. In the first place, it must be remembered that the sum of the reactions at the supports equals the weight of the beam plus the loads. This simple principle is sometimes forgotten in complicated problems and leads to gross errors in the calculations. The simplest method of working all such problems is to consider one end of the beam pivoted as at *S*, and find the force at *P* necessary to swing the beam and load about this pivot. The upward force or reaction at *P* has a 10 foot lever arm, so that its effect, called its moment, equals P multiplied by 10. The effect of several loads working against the moment of P, equals the sum of the products of each load multiplied by its distance from the pivot, or $700 \times 7 + 500 \times 5 + 600 \times 2 = 4{,}900 + 2{,}500 + 1{,}200 = 8{,}600$. This sum must equal the effect of *P*, or $P \times 10 = 8{,}600$, and $P = 8{,}600 \div 10 = 860$ pounds.

As the total load on the beam equals $700 + 500 + 600 = 1{,}800$, that at *S* $= 1{,}800 - 860 = 940$ pounds.

Beside the proportion of the load that each pier must support, the weight of the beam and any other local weight, as at *K*, must be added so as to determine the total on each foundation. If the beam weighs 2,000 pounds the total pressure at *S* equals $940 + 400 + 1{,}000 = 2{,}340$, and that at *P* $= 860 + 1{,}000 = 1{,}860$ pounds.

Sometimes it is possible to weigh an extra heavy casting by supporting it on two scales at once. In case the casting is supported by slings from over-head scales, care should be taken to have the supporting chains hung vertical as at *A*, Fig. 5, and not as shown at *B*. If the chains are not vertical, the sum of the scale readings will be greater than the weight of the casting.

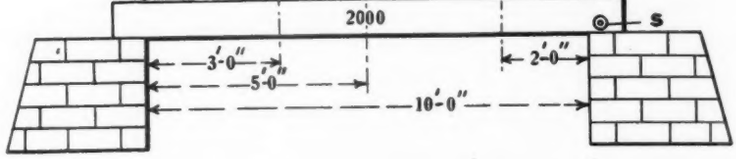


FIG. 4—METHOD OF OBTAINING THE PRESSURE OF A LOADED BEAM SUPPORTED ON PIERS

Slag in the Tuyeres.

By W. J. Keep

Question:—We are troubled with slag, or a kind of sponge-like dirt, running into tuyeres and wind belt towards last of the heat when the wind is reduced. We melt about six tons of iron and use about 50 or 60 pounds of limestone broken up small for flux, and we have about 11 ounces of blast pressure.

Answer:—You do not give the size of your cupola, but it is probably small. If 60 pounds of limestone is distributed throughout the heat, the amount is correct. When you use limestone, you must slag your cupola, because the lime makes a fluid slag, and when the blast is reduced, it must necessarily run out of the tuyeres. The slag should be kept below the tuyeres. Use about 20 pounds of good limestone to each ton of iron melted.

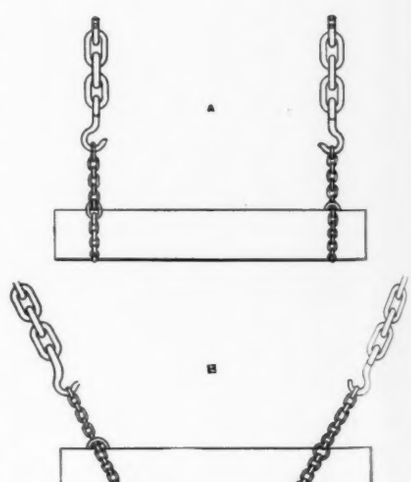


FIG. 5—PROPER AND IMPROPER USE OF SLINGS IN WEIGHING CASTINGS

A MODERN RAILROAD REPAIR FOUNDRY

New casting shop of the Delaware, Lackawanna & Western Railroad, at Scranton, Pa. --- Novel features of arrangement and construction

AN extensive general repair plant has recently been completed at Scranton, Pa., by the Delaware, Lackawanna & Western Railroad Co. Among the features of this new plant is the foundry, which includes both brass and gray iron departments, the latter embracing general floor and bench work and also a small cast iron pipe shop. All departments are under one roof. Many of the latest ideas in foundry design have been worked out in this new shop, which also contains a number of unique and original features. To those who are familiar with many of the railroad foundries of a few years ago, the one herein described represents an almost immeasurable advance and testifies to the truth of the statement that the railroads of today are thoroughly alive to the advantages of modern facilities and thoughtful design.

Construction of the Foundry.

Fig. 1 is a general view of the interior of the new foundry. The simple, strong, fireproof construction, ample light and ventilation are evident from this illustration, which also shows the liberal distribution of power operated auxiliary jib cranes serving the main bay. At the extreme rear of the building is situated the pipe department. The bay to the right will be given up to light floor and bench molding. The two cupola spouts may be seen on the left just under the traveling crane. These are shown to better advantage in Fig. 3. Referring further to Fig. 1, the brass department is situated in the left foreground. On the raised platform in the immediate foreground are the cleaning and shipping departments.

Pipe Shop.

The building is 400 feet long; the main bay is 60 feet wide and each of the side bays is 30 feet, making the dimensions of the building 400 by 120 feet. The pipe foundry department includes a pouring pit, ramming pit, with clay pit on a lower level, and a gas-fired drying oven. A large number of short lengths of pipe will be cast and to accommodate these molds a series of bearers have been fixed into the walls of the pouring pit. The greater part of the equipment for the foundry was furnished by the Whiting Foundry Equipment Co., Harvey, Ill.

The melting equipment consists of two Whiting cupolas 63 and 78 inches in diameter, respectively. Both cupolas are 55 feet in height. Each cupola is fitted with an operator's platform extending completely around the wind box, which enables the operator to make a complete inspection of his tuyeres at any time. In front of the cupolas is built a light, structural steel, tapper's platform, Figs. 3 and 4, connected with the foundry floor by steel stairways. The blast is supplied by two Sturtevant positive blowers, size Nos. 9 and 10, direct-connected to General Electric alternating current motors. These features are all clearly shown in Figs. 3 and 4. The capacity of the 63-inch cupola is 14 to 18 tons per hour and of the 78-inch 29 tons per hour. On the ground floor behind the cupolas is located a 36 by 60-inch Whiting cinder mill.

Charging Machine.

The charging floor is of reinforced concrete construction. It is 60 by 30 feet in size with an outdoor platform 60 by 13 feet 7 inches, affording plenty of space for the storage of charges. The charging floor is reached by a four-ton hydraulic elevator. A Whiting charging machine of improved, special design, is fitted to the 78-inch cupola. This

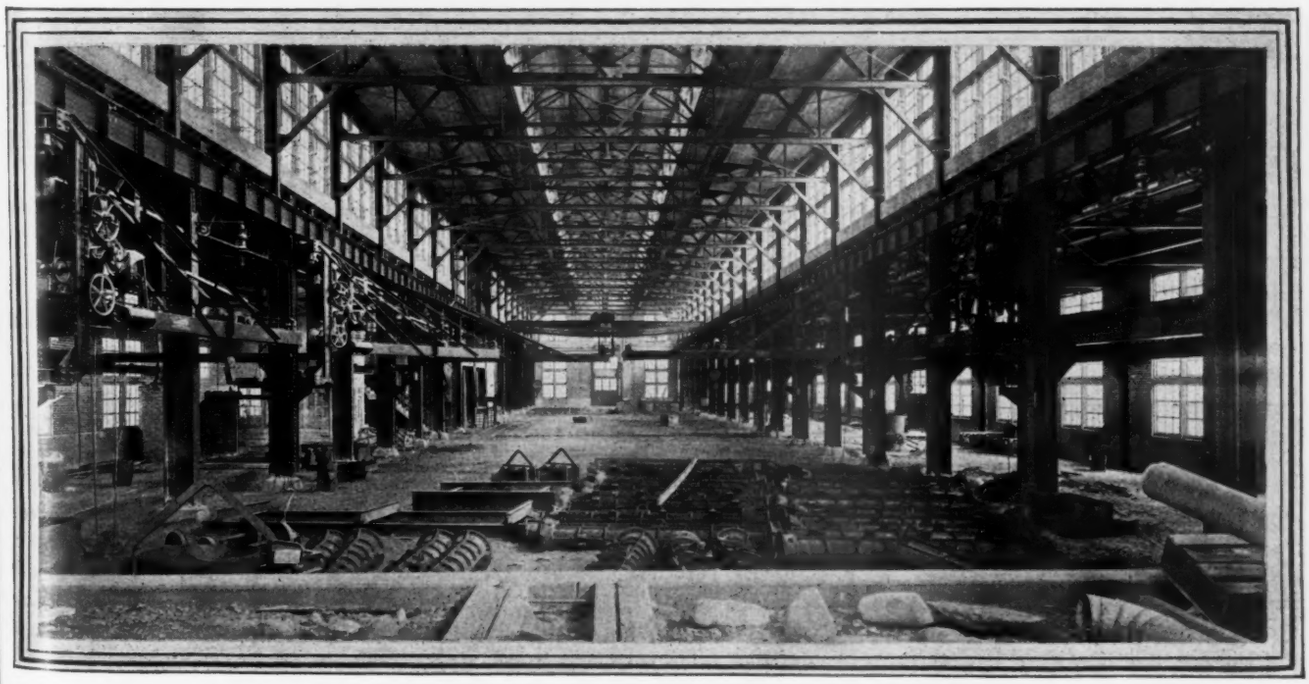


FIG. 1—GENERAL VIEW OF THE D., L. & W. RAILROAD FOUNDRY AT SCRANTON, PA., LOOKING TOWARD THE PIPE CASTING DEPARTMENT

machine is shown in Figs. 5 and 6, which illustrate both the normal and charging positions. The machine consists of an elevator running in a structural steel frame. The elevator is designed to carry a 3-ton charging buggy and is operated by an electric, motor-driven hoist situated overhead. The charging door of the cupola is about 6 feet above the floor. The machine raises the loaded car about 5 feet 9 inches and then the chains attached to the guide pulley, which runs on the inclined guide rails shown in Fig. 5, dump the load into the cupola. The car is inclined to an angle of about 45 degrees. In connection with the machine, a complete equipment of specially designed iron and coke charging cars has been supplied.

Internal Transportation.

A study of the internal transportation facilities of the foundry reveals two very interesting features, namely the very liberal use of jib cranes to supplement the traveler and the subway system. Extending completely around the building near the walls is a narrow gage subway in which are operated cars carrying coke, sand, iron, finished castings and other materials. The cars are handled with small electric locomotives. The subway connects at two convenient points with elevators which raise the cars to the surface and surface tracks are laid in portions of the shop.

The subway has proved very convenient. It connects with the other shops and does not interfere with the standard gage tracks on the surface. Also, the floor of the foundry is practically free from surface tracks. The sand, coke and other material bins are designed to discharge into subway cars; the waste sand from the pipe department is also discharged through chutes into cars in the subway.

Elevating Turntables.

In a few special cases where the narrow gage and standard gage surface tracks cross and it is very inconvenient to install ordinary turntables for the narrow gage, a special design of elevating turntable, illustrated in Figs. 7 and 8, is used. This turntable lifts the car from the tracks. The details of the mechanism are clearly shown in the photographs. The plunger is operated by compressed air. A standard Westinghouse locomotive compressor is attached to a nearby column.

To supplement the traveling crane and facilitate the rapid handling of flasks and heavy weights in the main bay, five Whiting electric, portable bracket cranes, of 5 tons capacity each, are installed. The cranes are rapid action and are controlled entirely from the floor. In addition, the main bay is served by a 15-ton standard Whiting electric traveling crane.

The pipe foundry end of the building is supplied with a 5-ton electric traveling crane of special design. This crane has a factor of safety of 10 throughout. The hoist mechanism is located at one end of the bridge and the load is hoisted with a chain instead of a rope. This crane is shown clearly in Fig. 2.

Core Ovens.

As was described above, the pipe casting pit is arranged for ramming in one corner. Near the pit are two core ovens for drying pipe cores; these ovens are fitted with cars and a complete equipment of core trees and racks. Both the core ovens and drying ovens are gas-fired. In connection with the pipe department are also the necessary sweep stands, with sweep boards, hay rope machine, mud mills,

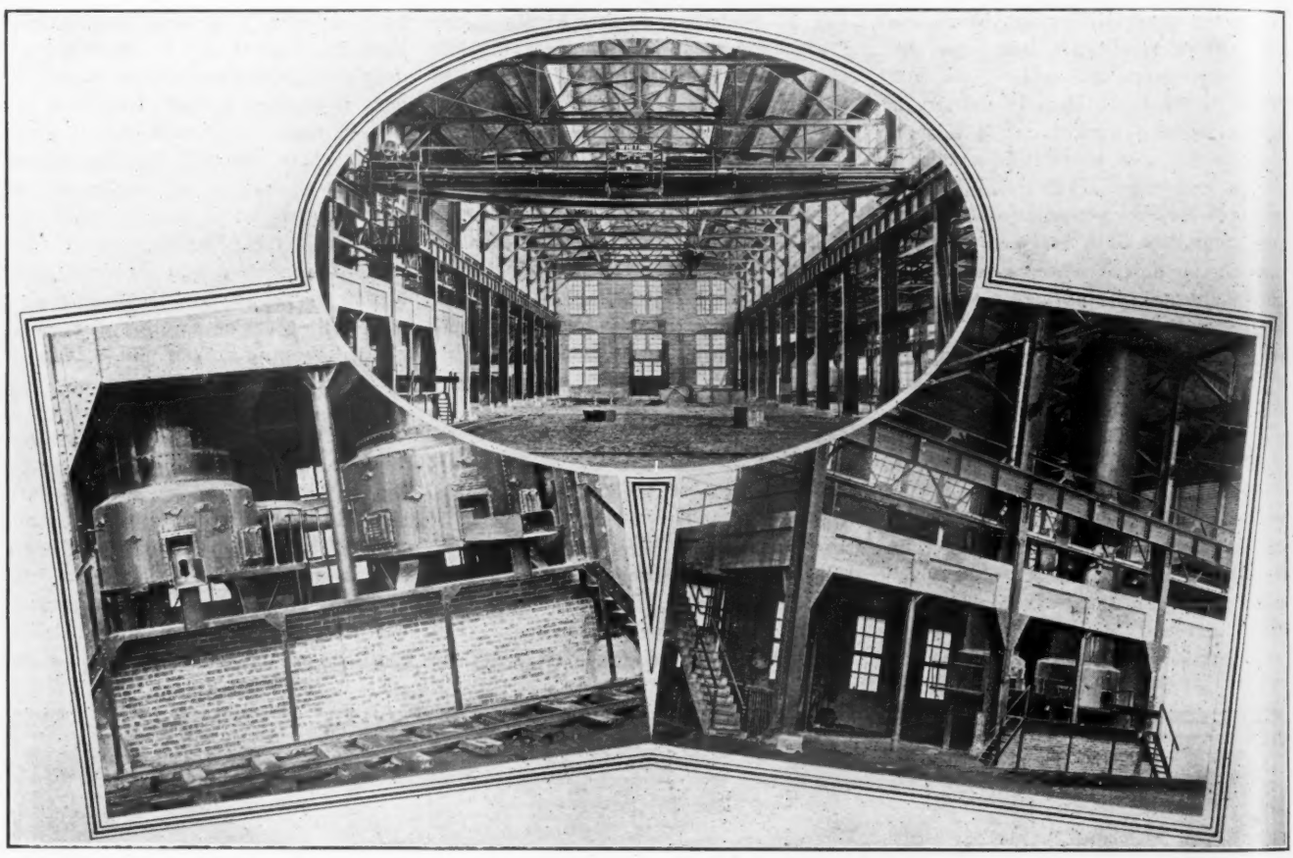


FIG. 2—PIPE CASTING END OF FOUNDRY, SHOWING CRANE OF SPECIAL DESIGN

FIG. 3—THE TWO CUPOLAS PROVIDED WITH A TAPPER'S PLATFORM

FIG. 4—VIEW OF THE CUPOLAS, SHOWING THE CHARGING FLOOR

etc. Complete equipment of flasks, pipe patterns, core boxes, cleaning tools, slings, pouring dishes and skids for casting pipes from 4 to 12 inches in diameter is installed.

Gray Iron Shop.

The gray iron department is supplied with the usual equipment of core and drying ovens including one oven 18 by 25 by 16 feet, one oven 9 by 25 by 9 feet, each fitted with the necessary cars, and four drawer type ovens of five drawers each, all built by the Whiting Foundry Equipment Co. The fire boxes for the core ovens are located in the subway.

Four, 36-inch diameter by 60-inch, spur geared tumblers, a No. 2 Blake core wire straightener and motor-driven grinders are installed in the cleaning room. For cleaning grates, etc., a sand blast machine is provided. The grinders, tumblers and sand blast machines are all connected to an efficient exhaust system which insures a practically dustless cleaning room.

Brass Foundry.

The side wing of the cleaning room end of the building has been fitted with equipment for brass molding and melting. The melting equipment consists of two No. 3 Whiting, coke-fired brass furnaces. The fireboxes for the furnaces are situated in the subway. This section of the foundry is also supplied with core oven equipment consisting of three-section drawer type ovens of five drawers each. The coke ovens and brass furnaces use a common stack. In addition are installed a cinder and ore crusher, a band saw, a magnetic separator, brass tumblers and motor-driven grinders.

The scrap yard is covered by an electric traveler for handling flasks, iron, sand, etc. For breaking castings a skull cracker, consisting of a structural steel tower with a motor-driven hoist, arranged to stop automatically at the end of travel, is provided.

A wide range of work passes through the foundry, including ordinary locomotive and car repairs, mine equipment and repairs, mine pump repairs, cast iron pipe and fittings, etc. The plant will be called upon to do but little manufacturing but must be able to cope with a great variety of repair jobs in a minimum time. The extensive and varied equipment of the shop is designed to produce the best results under these conditions.

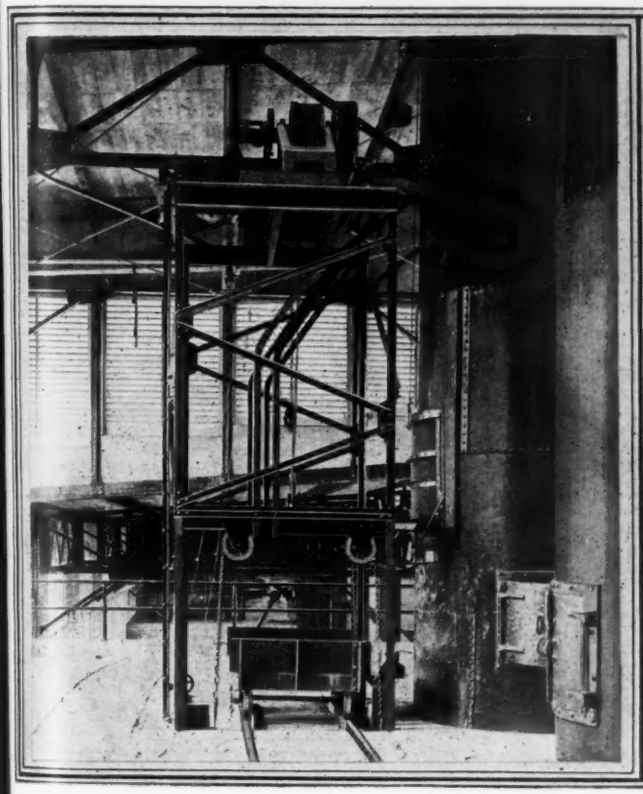


FIG. 5—CUPOLA CHARGING MACHINE IN NORMAL POSITION

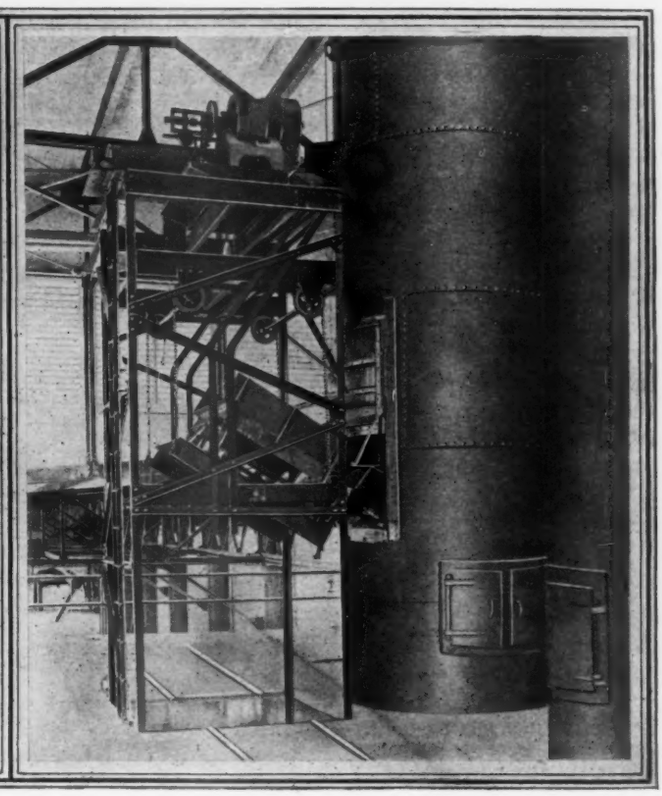


FIG. 6—CUPOLA CHARGING MACHINE IN CHARGING POSITION

The annual autumn meeting of the council of the Institute of Metals will be held in Glasgow, Scotland, Sept. 21 and 22. A local committee, of which Prof. Archibald Barr is chairman, and Dr. Cecil H. Desch, honorary secretary, has been formed to make the necessary arrangements for the meeting.

Running a Foundry Full Time

By Darby O'Quill

WHILE the above caption may, in some respects, fail to technically represent the meaning of the following article, it is nevertheless true in most cases that foundries are not run full time; at least the great majority do not work to their full molding capacity, that is for the full number of hours they pay for. In other words, the system of the forenoon suffers a shock in the middle of the afternoon, about the time it may be found necessary to start molding. Blast time, to the average skilled foundry employe, is a sort of magic moment, when he may either stop work, smoke up, or go home. The practice sometimes varies according to localities, and it has its various degrees of obstreperousness against any change of customs or conditions, regardless of their reference to right or wrong.

Some shops allow their men to go home as soon as poured off, a creditable practice as far as it goes, inasmuch as it is rank cruelty to keep a man around a cold foundry with wet clothes on him. Other men, not in the heat at all, may in other places

go home or stop work. There is an element of injustice to the men in the whole method, and much dissatisfaction is caused by having the same men, day after day and week after week, getting out early, while their more unfortunate brothers have to stay late every evening.

It is not to be denied that this prevailing system is as old as the industry, and while it suffers a rude shock occasionally, it is still in vogue in the vast majority of foundries.

The high wages of mechanics during the past decade has set some of the best minds thinking along lines of improvement in this direction, when heavier tonnages are called for and strenuously urged; but the fear of labor troubles during periods of great prosperity, when any change in systems or management takes place, has been more of a serious drawback to real advancement than panics or hard times.

Generally speaking, foundrymen like to make improvements, both in methods and systems, but they are always too poor when a slackness comes, and when they get a rush of work they have no time.

Introducing the system of "full time," that of paying the molders molding and the coremakers coremaking for the full number of hours they are paid for, having a small crew picked from the regular day gangs, and organized into a regular "pouring" and "shaking out" crew, is not attended with any difficulties when diplomatically handled. The writer has, during the period of our greatest prosperity, introduced this system successfully in three of the largest shops of the middle west, and has been in one of them during the past year where as much as 100 tons per day is produced on this system, and on a variety of work running in weight from one pound to 50 tons.

The molders, light and heavy, take no notice whatever at what time the blast goes on, as they simply keep on molding until the whistle blows. It is common practice in the shop to see molders making molds while their work is being poured or even shaken out. On the other hand, the blast being only put on to best meet conditions, it very often happens that all molders have left the shop before a drop of iron is poured.

Each assistant foreman pours his own gang, keeping one laborer to help him steady the ladle, as all the work is poured from the crane. The work is of great variety, as far as weight is concerned, and is high grade, consisting almost entirely of Corliss engine castings.

Steel Foundry Practice.

This method of operating foundries is almost entirely in vogue in steel foundries all over the country, and it is nonsense for the gray iron foundrymen to be hanging to the skirts of tradition, and in some instances proclaiming that the work cannot be done by others than the regular molders. Intelligent molders, nor as far as we are aware their unions, have any objection to the plan, at least if they have we have never heard of it. It is far better for the molder to be kept molding than to be cutting sand, digging holes, pouring iron or shaking out, and it is also better for the foundryman, as when the molder is molding he is producing castings, and that is what counts.

Economies Effected.

It sometimes requires great efforts to get away from a custom that has prevailed for generations, and the ex-

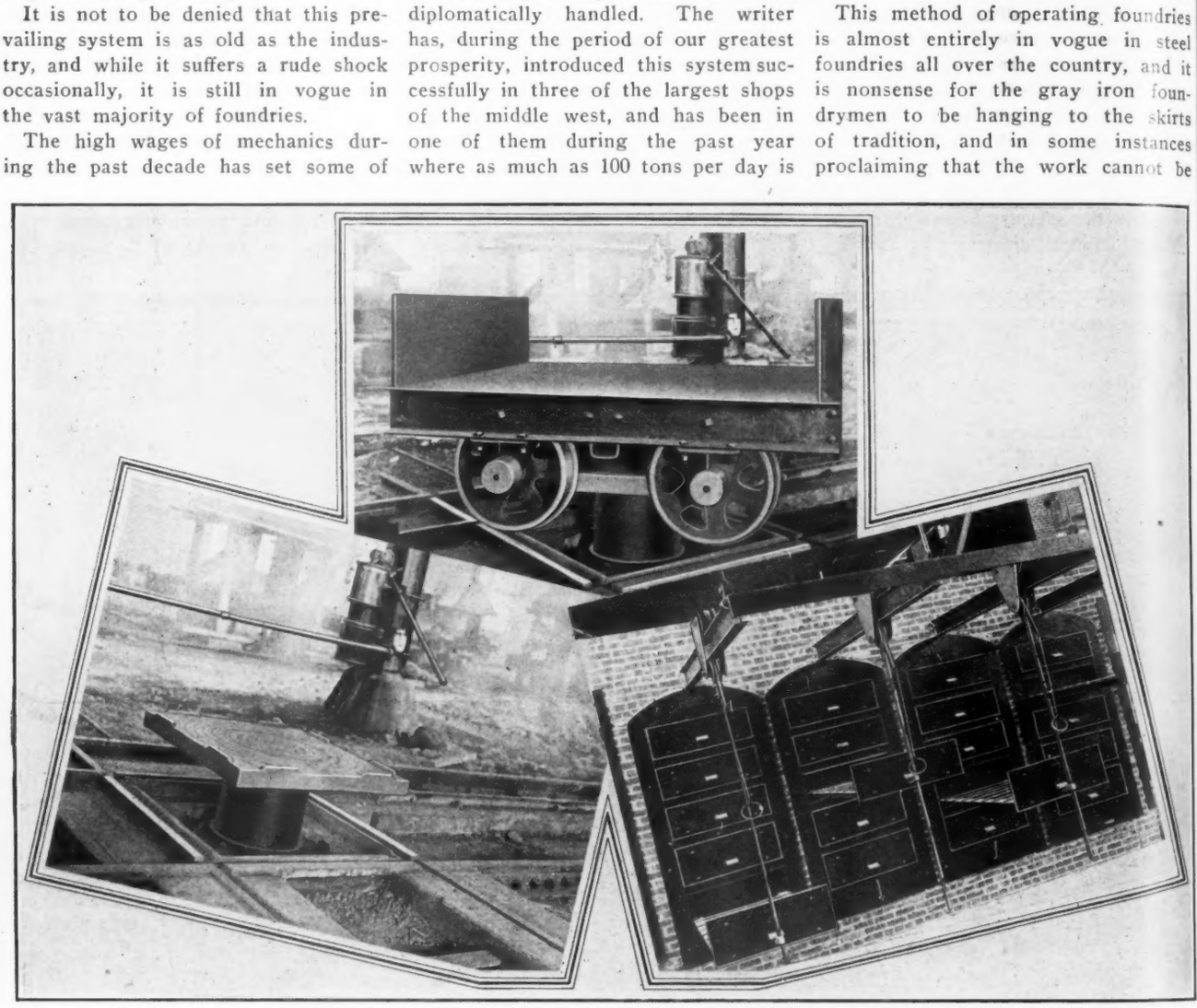


FIG. 8—CAR RAISED FROM THE TRACK BY ONE OF THE ELEVATING TURNTABLES

FIG. 7—ONE OF THE ELEVATING TURNTABLES

FIG. 9—BATTERY OF CORE OVENS

ecutive departments find it as hard if not harder than the workmen. That this system of conducting a foundry is a great cost reducer and increaser of output from the same space, is too apparent to need tabulation or array of figures to prove. The ordinary molder will do at least 10 per cent more work than under the old way of working.

The writer well remembers, about seven years ago, when he began to change the existing order of work, and as a starter, had all sand cut up, pits properly dug and flasks brought in on the floor, ready for molding when the whistle blew in the morning. While everything did not go according to program, it was given a fair trial, straightening out a kink now and then, until the system was going so smoothly that the cutting of sand, etc., was, before one month, considered a part of the shop system. When a balance was struck for the first month, the cost of castings showed a reduction of $2 per ton. In about three months, the system was extended to embrace the pouring-off and shaking out, and in less than 60 days the cost of castings dropped slightly over $2 per ton more, or over $4 altogether. The whole of this saving could hardly be credited to the time saved, as the writer was compelled to introduce several minor improvements to accommodate the new order of things.

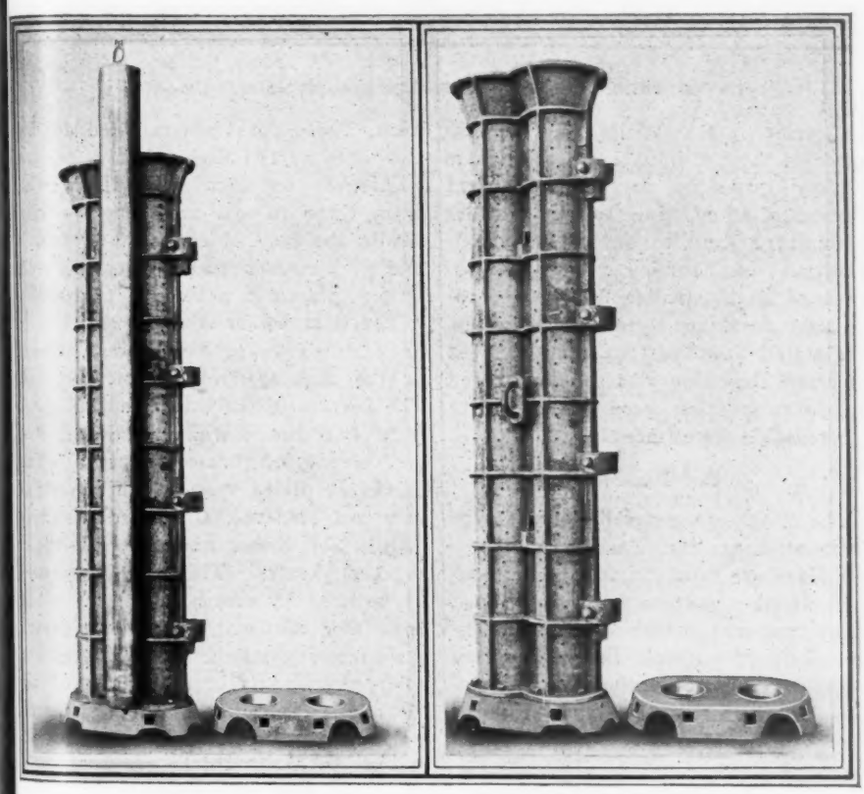


FIG 10—PIPE FLASKS, SHOWING CORE ARBOR AND CORE PRINTS

Losses.

The losses of castings incident to the introduction of the system I found to be practically nothing. Indeed, it works the other way, as not all molders know how to pour work as well as a man thoroughly trained for the purpose. One thing should be emphasized, and that is that gates and risers must be standardized, as far as possible. This is a very simple job when gone about properly. There is but very poor success in any shop doing a class of work that must be clean and sound, where molders are allowed to cut any kind of a gate they please, or run their work with any degree of speed that their rule of thumb notions may lead them to think is right.

Gates.

The gates for clean work must be fool-proof, as far as dirt traps are concerned, and it was for this purpose that the writer invented and put into use a centrifugal gate. Runner basins must be properly built, care being taken that they are deep enough and of sufficient area to hold enough metal to keep the down gates full, without any whirl or sucking effect during the whole of the pour.

When a properly made mold is enclosed in a properly constructed flask, and with gates and runners made and cut in accordance with correct practice, no anxiety whatsoever need be felt as far as getting a good casting is concerned, the molder's presence while it is being poured having no effect one way or the other. The lighting of vents, churning, matching-up, and the several other operations attendant on the pouring of molds—which are more superstition than correct practice—might be eliminated entirely in a majority of instances.

The Foundry Floor

By W. J. Keep

Question:—We are erecting a new foundry, and are undecided as to what kind of a floor to put in. Cement has been suggested, but we had an idea that it would require constant repairing, and would be hard on shovels. What has been your experience in this respect? Our product will be stove plate.

Answer:—The molding floors should be made of 6-inch cupola cinders or broken stone, leveled with fine materials, either from cupola refuse or boiler cinder. On this lay 1 or 2 inches of sharp sand, or enough so that no piece of coarse cinder shall reach the surface; level this with a straight edge, then lay hard red brick flatwise, breaking joints lengthwise; make the bricks solid and level by pounding them down with heavy pounders, striking on a cushion of plank, so as not to break the bricks; then make a grout of one part cement and two parts of sharp sand, and pour it over the whole surface, until all the cracks are filled. Leave no cement on the surface, except to fill cavities and uneven places. Let this set over night. It is better to have no markings for alleyways, but to cover all alike. The floors can then be changed whenever it may be thought desirable to introduce new methods of molding, and of cutting sand. The brick gangway is the best, as it resists molten iron, better than anything except clay. Cement does not last at all. Clay is best for gangways, but it is difficult to keep the surface level. A clay molding floor is the worst of any, because it will not be level, and clay will be shoveled up, and mixed with the molding sand. A molding floor for stove plate should be absolutely true, level and hard. The shovels will not be injured to any extent, and the saving in having castings true will more than balance first cost or wearing out of shovels. Stove plate will come true, if the floor is true.

A Grate Bar Difficulty

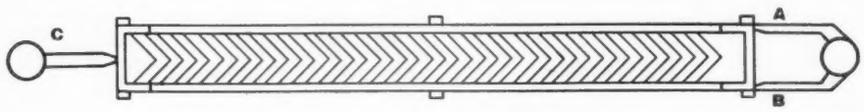
By F. Webster

WHILE the molding of grate bars is one of the oldest tricks in the foundry, yet it is common today for the beginner on this class of work to obtain castings that he does not want. This is especially true when the molder tries to make some of the creations of ingenuity that support the clinkers in odd kinds of fireboxes. But the old fashioned and well established herring-bone, or fish-back grate bar also gives trouble enough to the molder to shatter his temperance resolutions. In fact a company, which is one of the largest users of this form of grate bar, is wise enough to steer clear of trouble when it can. This concern furnishes the patterns from its well-equipped shop to one or more lesser foundries that are willing to carry the molder's troubles for the fun of having the contract for grate bars. This style of bar is largely used because the shape of the cross-pieces permits expansion and contraction without seriously warping the side supports of the bar. Hence these bars will last longer in severe service than the ordinary straight form of bar.

Method of Molding Grate Bars.

A method of molding a 4-foot, 200-pound herring-bone bar, that has been used with success in one foundry, is shown in the accompanying illustration. This work is done in the ordinary small foundry where green sand molds are used, and the wooden flasks are tamped by hand in the usual, old-fashioned manner. With the modern molding machine the proposition would be entirely different.

The important points considered in molding this bar are those relating to the gate and the riser. By referring to the sketch it will be seen that the gate is divided into two leaders so that the metal enters the mold at *A* and *B*, immediately in line with the side flanges of the bar. It will be seen also that the gate is located at the end of the bar, which will cause the metal to flow into the cross openings by backing up. When the gate was tried at the other end of the bar —the first trials were made this way— so that the metal flowed directly into the wedge-shaped openings, the thin cross cores were washed down and broken or otherwise injured. A riser, *C*, was placed at the other end. The thin cross cores were strengthened by pieces of wire, several to each core.



METHOD OF GATING GRATE BARS

Numbering Foundry Flasks

By H. N. Tuttle

IN ANY foundry, where a large amount of repetition work is done, of castings weighing from 25 to 2,000 pounds, it is generally desirable to make a special iron flask for each particular job. While this entails quite a heavy initial expense, it is rapidly made up in the subsequent saving of time, due to the smaller amount of sand to be rammed, convenience of handling, venting, stiffness of flask, smaller floor space required, durability, etc. Incidentally, perforated iron bottom boards, with inverted T section ribs or cleats cored on, to raise them from the floor, are a profitable investment.

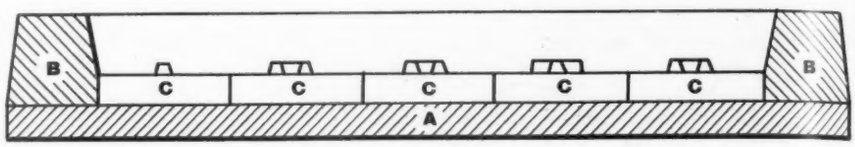
Cut Flasks.

The flasks are generally of the type designated as "cut flasks", in which the sides are "cut" to follow the parting on the pattern. In this way, many patterns which would be extremely hard to mold in the ordinary flask, on account of the difficult coping, become as easy to make as if they required but a simple flat parting.

Where the number of these flasks is large, comprising many sizes of similar style, it becomes quite difficult to distinguish them as they are piled in the flask storage room. Generally the man who has charge of the flasks learns to recognize them by certain indefinable characteristics, aided by his memory as to where he had previously placed them, and by this seeming miraculous power is usually able to produce any desired flask. But should this man be absent, it generally requires the conference of the foundry foreman, a molder or two and three or four helpers, and the final trial and rejection of two or three flasks before the right one is found.

Numbering the Flasks.

To conveniently obviate this difficulty, the following device was resorted to. An interchangeable number core box was made, with a range equal to all the possible numbers of patterns. Several cores are made for each flask, bearing the number of the pattern which is to be molded in the flask. These cores are rammed against the sides of the flask; if it is square, a number on each side; if circular, from three to six, according to size. While the face of the core is flat, it will fit a circular flask sufficiently well, if it is placed in a vertical position.



LONGITUDINAL SECTION OF CORE BOX FOR NUMBERING FLASKS

The box, which is made entirely of brass, is shown in longitudinal section in the accompanying illustration, *A*. The bottom of the box is made of ⅛-inch sheet brass, while the sides, *B B*, are pieces of brass runners. The blocks or plates upon which the numbers are soldered, *C C*, are also ⅛-inch sheet brass, and are all made exact duplicates. This may very easily be done by means of a gage block on a disc sander. Upon these plates the necessary numbers and letters are soldered. From three to four of all the digits, according to the system of marking the patterns, as well as all the letters used, will be required. The core box should be accompanied by a box with a cover, in which the extra numbers, and the core box, should be kept when not in use.

A new metal exchange has been organized in Hamburg, Germany, to deal in copper and tin only. In addition to the usual exchange transactions, this exchange will permit of the closing of contracts for future deliveries 6, 9 and 12 months ahead. In this way the manufacturer will have an opportunity of covering his sales for the entire contract period. Furthermore, the minimum quantity dealt in has been placed at 10 tons, and in the multiple of 5 upwards. The Vernon Metal Co., 30 Church street, New York City, has direct foreign connections through whom transactions can be made on this exchange.

THE BRASS FOUNDRY

Latter-day Methods of Gating Metal Patterns

By W. R. Dean

BEFORE metal patternmaking became an art, there was no system of gating patterns, and the kind of metal of which the castings were to be made and its relation to the size and shape of the gate were rarely considered. The only object was to fill the flask with patterns, and little attention was paid to the manner in which this was done.

Since the advent of the strong bronzes, such as manganese, aluminum, etc., the metal patternmaker has had to learn new ideas as to gating patterns, and what was formerly left to the molder is now done by the metal patternmaker. He ascertains what the patterns are to be made of, and how they are to be poured, whether from the end or middle of the gate and arranges his gating accordingly. He should either be a good molder or in touch with a good molder. A pattern gated for iron should not have the gate as heavy as one gated for brass or composition, and these metals require a smaller gate than the stronger bronzes.

Metal for Patterns.

An essential feature of metal patterns is the metal of which they are made, and they should not be cast from any metal that may happen to be in the furnaces, irrespective of whether it is brass or composition. The main requirements of a good pattern metal are, that it must cast well, giving clean, sharp castings, must not be too hard to file or cut, and sufficiently stiff to maintain its shape when in use.

The last requirement is essential, as a pattern receives much rough treatment, and if the metal is too soft the pattern bends out of shape. A good tin bronze is always satisfactory, but in the case of small pieces like hinges, washers, etc., a cheaper mixture can be used. The formula given herewith, gives a good, clean casting, the equal of any tin bronze, and if the molder cuts heavy gates, ignoring the runner soldered onto the master pattern, there will be no shrinkage in the casting, and the cost of cutting off the heavier gate is more than offset by the cheaper metal. This alloy follows: Copper, 50 pounds; zinc, 34 pounds; lead, 4 pounds, and aluminum, 3 ounces. The proper temperature at which to pour this metal is when it flares slightly when the surface is disturbed by the stirring rod. Then it makes very smooth, clean castings. In the case of very thin castings, it may have to be poured hotter, while heavy ones will need feeding by means of rings, and sometimes it may be necessary to churn the heads.

The lead in the mixture gives good filing qualities, the aluminum makes the castings run sharp and clean and eliminates the dirt that generally accompanies the use of so high a percentage of spelter.

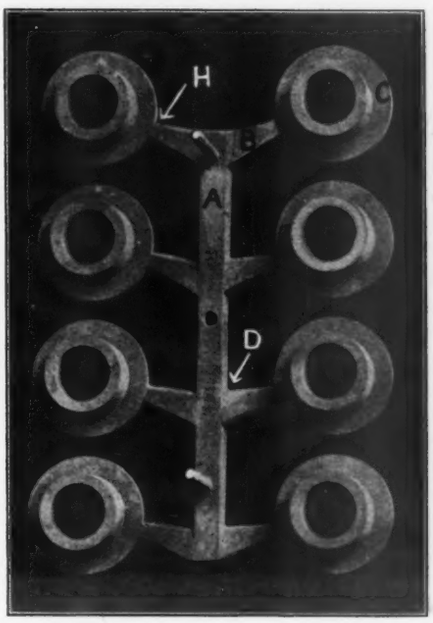


FIG. 1—METHOD OF ATTACHING PATTERNS TO GATE

Other Mixtures.

A good tin bronze for purposes for which the foregoing mixture cannot be used consists of copper, 10 pounds; tin, 10 ounces; zinc, 5 ounces and lead, 2½ ounces.

For patterns with moderately thin parts, use copper, 10 pounds; tin, 15 ounces; zinc, 5 ounces; lead, 3 ounces, while for very thin patterns the following is recommended: Copper, 10 pounds; tin, 18 ounces; zinc, 5 ounces and lead, 3 ounces. These four mixtures serve every purpose, the last two are hard and should only be used when castings with thin sections are being made.

Cost of Mixtures.

The copper and zinc mixtures run as well as any of the tin alloys given, and with a little judgment can be used to excellent advantage. We use them continually with very little loss, and the patterns are as easy to finish when made of this metal as any other, while the economy of using it is indicated by a comparison of prices. The zinc alloy, at a recent price of metals, cost 10¼ cents per pound, which, figuring a 5 per cent loss, would be 10¾ cents per pound. The cost of No. 1 bronze with a 1 per cent loss is 14¼ cents per pound, a difference in favor of the zinc alloy of 3½ cents per pound.

Gating Metal Patterns.

The first operation in metal patternmaking is to obtain a master pattern. This is usually wood, and the gate and runner are attached to it. It is better practice to solder the gate onto the runner than the casting onto the gate, as there is a better surface to solder at the juncture of runner and gate. This is shown in Fig 1, *A* being the runner, *B* the gate and *C* the cast-

ing. It will be clearly seen that if *B* and *C* are cast in one piece, a much stronger joint can be made by soldering pattern and gate to the runner *D*, than would be the case if runner and gate were one piece, and the separate pattern attached at *H*.

Master Pattern.

The master pattern must be large enough to allow two shrinkages and finish, the latter need be only sufficient for filing and smoothing with emery cloth. If the castings are not made of good metal, the master pattern must have more finish left on it, and it takes longer to get the castings sufficiently smooth to leave the sand clean, therefore, it pays to have good smooth castings. Very often, those desiring good patterns, pay as high as $1.00 a pound for them, but the time saved in finishing amply repays the extra cost of the metal.

Casting the Pattern.

The master pattern should be given to a good molder, and the required number of patterns made. The best results are obtained by using a small jeweler's flask, as it is easy to handle, requires less sand, gives a good lift and as a result the castings have no fins. Very fine sand should be used, such as Albany or Windsor Locks, for a facing, in order to obtain a smooth surface, as coarse sand will not make smooth castings. The mold should be skin-dried and smoked with a benzine torch, or a little fine flour

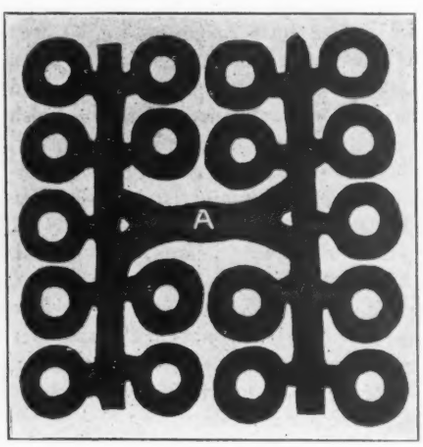


FIG. 2—SHOWING GATE ARRANGED FOR SNAP FLASK MOLDING

may be dusted on. Either gives good results, and causes the sand to peel from the casting, keeping small particles of sand from breaking loose and washing into the metal. The mold should be closed while warm and poured as soon after as possible.

For the simpler forms of patterns, where no small flasks are handy, the molder can bed-in the patterns, and thus obtain small castings in one flask by the use of one master pattern. A first class molder can do this successfully. We have obtained ex-

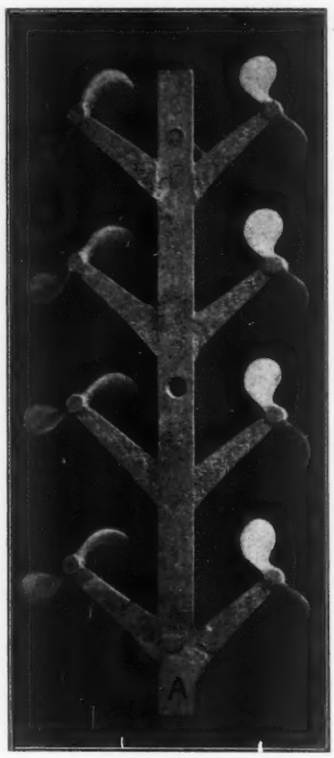


FIG. 3—PATTERNS GATED TO BE POURED ON AN INCLINE

cellent castings by this method, but it requires skill and is only recommended when the small flasks are not available.

Soldering Gates to Runners.

As previously explained, the section attached to the pattern is called the gate, the runner being the section to which the gate is attached. The runner is a very important feature of gated patterns and much attention should be given to this section. To square runners with tapering sides, the gates can be easily attached without much fitting to shape, but if the runner is round, the end of the gate has to be filed to a curve to fit it, or a good soldered joint cannot be obtained. The fitting is thus much more difficult than in the case of the straight side runner. The gates are attached to the runners by soldering. The parts are first tinned, then sweated together, using very little solder, the less solder the stronger the joint. After being sweated on, the joint is tested, and if not solid is broken off and again soldered. We have patterns put together in this manner that have been in use several years and have never had one come off. Sometimes they have been dropped on to the floor to test them and the patterns have remained on the runner.

Draft and Fillets.

It is not necessary to give patterns an excessive draft, provided there are no sharp corners; it is a mistake, though, to give a pattern a straight draw. A slight draft should be given, and the sharp corners filleted, as they break away the sand, which may be overlooked in the mold, causing sand holes in the castings.

Gating for Snap Flasks.

Snap flasks are extensively used, especially for the cheaper class of work, in which aluminum can be added to make the castings run sharp. Other work can also be made in a snap flask, if there are not too many pieces on the gate, and the castings are not so thin that the metal must be forced.

Fig. 2 illustrates a pattern gated especially for snap flask work. The sprue is placed in the center at *A*, because the intention was to use no jackets, and if the sprue were placed near the sides, the mold would be burst by the pressure of the metal.

When gating for red or yellow brass it should be known whether the castings are to be poured from the center or the end, because in the latter case, a lighter gate can be used. Furthermore, the patterns are attached to the gate in a different man-

FIG. 4—SHOWING WRONG METHOD OF ATTACHING CASTINGS TO GATE

ner. Fig. 3 shows a gate arranged to be poured from the end at *A*, which allows the metal to flow directly into the castings. Fig. 4 shows a gate improperly constructed. The patterns should have been given a right and left hand draft, so they would all point one way, permitting

FORMULAS FOR THE BRASS FOUNDRYMAN.

Manganese Bronze for Bearings.

The alloy usually known as "Manganese Bronze" contains a high percentage of zinc, and possesses no value as a bearing metal. It is in reality a brass, deoxidized and strengthened, by the use of a small percentage of manganese, or other active deoxidizing elements.

Bearing alloys containing manganese may be divided into two classes, those in which the content of manganese is comparatively small, added with the idea of retaining high percentages of lead, but is insufficient in quantity to exert a bleaching effect on the copper, and the alloys in which the manganese is so high that the metal is bleached silvery white, with a dense bluish white fracture, and contains in addition to manganese, lead and zinc in alloy.

As the latter mixture is not so generally used, the formula here given is of the first class mentioned, and has given excellent service in the form of journal bearings for heavy interurban electric cars, running without any babbitt lining. The formula follows:

	Pounds.	Ounces.
Copper	65	
Manganese copper (30 per cent)	5	
Lead	28	12
Tin	1	4

The manganese copper is placed in the crucible at the time the copper charge has just begun to melt, a small handful of salt being added, also a half pound of borax, with plenty of charcoal to cover the surface of the metal. When the charge has become thoroughly liquid, the tin is added and lastly the lead, the metal being thoroughly stirred. All alloys containing manganese in quantity are difficult to cast, as the oxidation constantly forms a skin or film on the surface of the metal, which is sufficiently strong to check the flow, until the increasing pressure of the metal behind, bursts the film and folds it in. This produces a series of "cold shuts" on the casting. To prevent this, it may be found necessary to use aluminum, commmencing with the addition of 2 ounces and increasing the amount if the alloy does not flow freely.

FORMULAS FOR THE BRASS FOUNDRYMAN.

Brazing Metal.

Brazing metal is an alloy of copper and zinc, with sometimes small percentages of lead, added for the purpose of improving its machining qualities. The content of zinc varies according to the amount of heat the castings will be subjected to, while being brazed. The greater the quantity of zinc it contains, the more fusible the alloy becomes, therefore, when the more refractory solders are to be used, or when the castings are so thin that there is danger of crumbling, the more nearly the brazing metal approaches casting copper in appearance and qualities.

Zinc is used in preference to tin in making brazing metal, because the copper-zinc alloys possess a certain amount of ductility at a red heat, and do not crumble with the same facility as the copper and tin metals. The color of the metal varies from a coppery hue, with the smaller percentages of zinc, to a reddish yellow, with the higher percentages, the structure of the metal being fibrous. The formula that is extensively used for flanges to be brazed onto copper pipe is as follows:

	Per cent.
Copper	87
Zinc	12
Lead	1

The copper must be melted under a cover of charcoal, a little salt being added when the ingots become red. After the copper is melted and appears limpid beneath the charcoal cover, the zinc, having been previously warmed, is added in small pieces, the lead is then put in, and the mixture thoroughly stirred, when it is ready for casting.

THE FOUNDRY DATA SHEET, AUGUST, 1910.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

the metal to enter the mold in the same manner on either side of the gate. As it is now arranged, the metal must flow backward, when poured from either end. The same idea should be carried out when patterns are gated as in Fig. 2, which shows the correct method of gating, as the metal has a direct flow into the castings.

Gating for Manganese and Aluminum Bronze.

Not many patternmakers understand the requirements in the way of heavy gates, shrink balls, and risers necessary in casting the strong bronzes. Such metals require gates on the heaviest parts of the patterns, and if the gates are too small, shrink holes will be found when the castings are cut off the gates. This indicates that instead of the casting drawing from the gates, the latter drew from the castings. As the thin parts cool first they draw from the heavier sections, and the gates should be heavier than the casting. Fig. 5 shows a gate of nuts which illustrates this, the gate at *A* being heavy enough to properly feed the castings.

When a gate and runner cannot be made sufficiently large, a shrink ball can be used. This is simply a ball of metal largely in the cope, gated to the casting where shrinkage occurs, and which supplies a reserve of liquid metal to feed the casting. When this fails, a riser is necessary, which sometimes must be churned before it solidifies.

When gating loose patterns in manganese bronze, the same general rules must be observed as for gated work, but sometimes the mode of procedure can be reversed, putting the gate on the thin part and a riser on the heavy portion. This is not practical with a gated pattern, because there would be too many risers to cut off. There is a limit to gated work in manganese bronze, because heavy castings cannot be placed on a runner with good results; no rules can be laid down in regard to this, it being a matter of experience, and if the latter is lacking, it often saves in the end to submit the question to some one able to advise.

FIG. 5—A GATE OF HEXAGON NUTS GATED FOR MANGANESE BRONZE

Steady Pins.

The object of steady pins is to guide the runner. When lifted from the mold, they should be slightly larger than the deepest part of the pattern. They should be made of brass and remain clean and smooth, the pins should be hard drawn rods, to resist bending. Rods 3-16 inch in diameter will give satisfaction. They may be inserted with a driving fit, and do not require soldering.

For small castings in white metal no shrinkage allowance need be allowed, as the molder will rap the castings sufficiently to make up the shrinkage. It sometimes happens, when the mixture contains a large percentage of antimony, the shrinkage is so small it cannot be measured, and occasionally the rapping makes the castings larger than the original.

A plain gate, that can be easily finished, may be cast solid, in which case white metal is useful, being cheaper and more quickly finished. A cheap white metal mixture is lead, 7½ pounds; tin, 1½ pounds; antimony, 1 pound. A better alloy is lead, 5 pounds; tin, 4 pounds; antimony, 1 pound. The latter is a good metal, but somewhat difficult to solder because of its low melting point.

When the patterns have been cast, in either bronze, composition or white metal, from the master pattern, it is necessary to smooth them, so they will easily draw from the sand. They are filed to remove all lumps, fins and imperfections, then finished with emery cloth, a polished surface being unnecessary. The allowance for shrinkage should receive consideration. Some claim that on small work this can be neglected, but our experience has proved the necessity of this precaution. The rapping of small castings by some molders makes up for the shrinkage, but others rap so lightly, that it is advisable to allow for shrinkage.

Fluxes as Applied to the Brass Foundry*

By Erwin S. Sperry

IN the early days of brass-founding, two things were guarded jealously—the mixtures and the fluxes. At that time it was not an uncommon occurrence to hear one say, when speaking of a new proprietor of a brass foundry, "He will get along all right. His father left him all his formulae for mixtures and fluxes." It seemed to be taken for granted that even capital itself was subsidiary to these heirlooms. Soon the chemist began to make serious inroads into the mixtures and their secrecy faded away gradually but surely. The mystery of the fluxes was more difficult to eliminate as, unlike the castings themselves, they did not go beyond the foundry. They could not be analyzed without obtaining at least a small quantity, and this was difficult to do, as the brass founder carefully guarded them and the materials from which they were made. In the course of time, however, the secret fluxes went the way of the brass mixtures, so that by the process of evolution, secrets finally became general technical knowledge.

The "Mystery" of Fluxes.

When fluxes are mentioned, it is frequently asked: "What is their advantage, and are they actually necessary?" To answer this question, I will say that I believe the flux question is greatly overdone and likewise imperfectly understood. It was only a short time ago that I discovered a brass founder using lime in making an 88-10-2 mixture from new metals. He said "somebody" had told him that it was good for bronze. Although cheap substance that it was he was wasting his lime, as it remained on the metal like so much dirt and had no more effect than sand. In another instance I found that a brass ingot maker used a couple of handfuls of a mixture of common salt and borax on the top of a pot of yellow brass after it had been skimmed and immediately before pouring. The mixture was thrown on and then at once skimmed off without waiting for the borax even to stop swelling. He too would have been equally as well off without the flux. Another, but diametrically opposite case, was a brass founder who attempted to melt

*Presented at the Detroit meeting of the American Brass Founders' Association.

his emery grindings in a crucible without a flux and obtained about a pint of metal and half a bushel of dross. In this case a flux was needed.

It hardly would be advisable to go into a detailed enumeration of all the fluxes known to mankind and that can be used in brass melting, as it would be of little value. Many substances once used for this purpose have now become obsolete and many others have proved to be valueless. It seems preferable, therefore, to give a description of those fluxes that the test of time has proved valuable and the manner in which they should be used.

Flux for Aluminum.

For years, those who melted aluminum used no fluxes at all, not even charcoal, as it was soon found that this material did more harm than good. On account of the lightness of aluminum, charcoal does not readily free itself and is apt to become entangled in the metal and produce small, black spots in the casting. It is within the past few years that a flux has become used.

For aluminum, the flux that is most extensively used, and which has proved to be so valuable is chloride of zinc. It seems to react with the aluminum, forming chloride of aluminum and metallic zinc which alloys with the aluminum. When this takes place the dross is changed to a fine, granular condition which is readily skimmed off. When aluminum is melted, the surface is covered with a rather thick mass, but the chloride of aluminum will change it to a perfectly clear one, closely resembling in appearance molten tin or lead. It is needless to say that such clean metal gives better castings.

The method of using chloride of zinc as a flux in melting aluminum is simple. Small pieces are thrown on the surface after the melting has been completed. Enough has been added when the surface is clear. A very small amount usually suffices and for 50 pounds of aluminum, a piece the size of a walnut is generally enough. The metal is stirred immediately after the addition and then skimmed. Those who have not used chloride of zinc should try it, as it is an excellent material.

Flux for Nickel.

The flux used by makers of nickel anodes has proved to be a good one. It was first used by A. M. Hill of New Haven, Conn., one of the first in the United States to make nickel anodes and the inventor of the well known "Hill barrel" for grinding brass furnace ashes. Mr. Hill has retired from the anode business, but for many years he used this flux with the best results. It is not only good, but cheap. It is composed of the following: Lime, three parts; and fluor-spar, one part.

The manner of making it is to take the lime and slake it as though mortar were to be made. Then stir in the fluor-spar and allow it to become solid. It is then broken into small pieces for use.

While fluor-spar alone is a good flux, it becomes very fluid when melted and rapidly attacks a crucible. I have seen a new plumbago crucible ruined in one heat when fluor-spar was used alone. It seemed to soak in and dissolve out the clay from the crucible mixture and leave nothing but the graphite. The crucible collapsed like an egg shell when grasped with the tongs. The use of the lime with the fluor-spar is to increase the melting point so that it will not so readily attack the crucible. The proportions previously mentioned have been found satisfactory for nickel. Less lime will render it more fusible.

This flux has been found particularly serviceable in melting old anodes, as it dissolves any earthy matter that may be on them. It is used for both new and old material, however, and may be called the standard flux for nickel. The proportions used are about a pint or a good handful for new nickel, and twice this quantity for old material.

It must not be imagined, because the fluor-spar is toned down with lime, that the flux will not act on the crucible, for it certainly will. The crucibles last only five or six heats. In this connection it should be borne in mind that all fluxes act on the crucible to a greater or less extent, otherwise they would not be of value as a flux.

Flux for Copper.

There probably have been more fluxes proposed or used for copper than for any other one metal or its alloys. The fact that copper cannot be melted alone and thus obtain sound castings, has brought about this situation. Practically every known chemical has been tried. In the selection of a flux for copper, it should be known whether pure copper castings are to be made, or whether it is to be alloyed to make brass or bronze.

To make sound copper castings with a flux alone, and without the use of "physic" like silicon-copper, magnesium or similar materials (which strictly speaking are not fluxes) is a difficult matter. For this purpose I have found that yellow prussiate of potassium (potassium ferrocyanide) is excellent. With it sound copper castings can be made, but I do not advise it, as far better results may be obtained by the usual deoxidizing agents, such as silicon-copper, magnesium, phosphorus, etc.

Melting Copper for Brass.

In melting copper for producing brass or bronze, the question is different from the preceding one. For this purpose there is nothing better than common salt. Its value lies in the fact that it possesses the property of reducing any oxide of copper which may form during the melting. It has been used for years in the brass industry and the memory of the "oldest inhabitant" fails to indicate the date of its inception.

Common salt is so efficacious in reducing oxide of copper that as far back as 1882, R. Monger in the *Chemical News* proposed it as means for determining the quantity of oxide that copper contains. His method was to melt salt in a clay crucible and then drop in the weighed sample of copper. After allowing it to remain for a short time, the crucible was cooled and broken, when the button of pure copper was obtained. The difference in weight gave the amount of oxygen, or its equivalent of oxide of copper. Some very satisfactory results were cited.

In melting the copper for making brass or bronze, about a handful of salt is used and is preferably put in after it has begun to melt. If introduced with the copper, it melts before the metal and is apt to volatilize and waste. The action on the crucible is also greater. Too much salt produces a liquid that is apt to penetrate the crucible like fluor-spar, although not as violently or as rapidly. The amount of salt previously given is used for a pot of metal holding about 150 pounds. The quantity need not be exact, as a variation either way does no harm as long as a sufficient quantity is used to do the work.

The theory of the action of the common salt seems to be that, at the temperature of the molten copper, it breaks up or dissociates into metallic sodium and chlorine gas. The latter escapes and the sodium performs its work in deoxidizing.

Flux for Brass.

The flux almost universally and exclusively employed in brass melting is common salt. As previously stated, its action is to reduce the oxide of copper formed in melting the copper previous to the addition of the spelter. The brass rolling mills in the Naugatuck Valley in Connecticut, and elsewhere as well, all use it and one large company

uses approximately half a ton a day. It is the universal and only flux used in making brass for rolling. For years it has been employed for this purpose. It seems to give all that is desired and has the distinct advantage of being cheap. Any kind of salt will answer and a pure material is unnecessary.

The quantity used is about a handful to the crucible. One concern uses one handful, while another believes that double this quantity should be used. A good sized handful, however, seems to be sufficient. It is added after the copper begins to melt as this appears to be the best time to introduce it. When the right conditions have been produced, there will be a little slag on the top of the brass when it is skimmed.

It is worthy of note that, although every brass rolling mill uses salt in brass melting, few brass founders who make sand castings employ it. Many of them never have heard of it and others seem to think it is a waste of time. I advocate its use under all conditions and as it is theoretically correct, has been found by actual practice to improve the quality of the brass, and is so cheap that the cost of the brass is not appreciably increased, it seems to me that every brass founder should use it, whether he makes new metal or melts scrap, as the character of his castings will be improved.

What has been said about the use of common salt in melting yellow brass, applies equally well to composition or bronze and it is used in identically the same manner and in the same quantities. It makes no difference whether phosphorus or other deoxidizing agents are employed, the salt is used just the same.

Flux for German Silver.

German silver is such a refractory material in the rolling mill that much time and thought have been given the subject of a suitable flux for it. It is a singular fact that the bulk of the German silver manufactured in the United States is made by two concerns. One uses a flux in making it, while the other uses none.

The use of the flux by the one concern dates back to 1869 when Frederic Wilcox, a brass caster who was engaged in making German silver, had trouble with black, minute spots in his metal. Tradition states that he gave the matter much thought and finally believed it was caused by carbon in the metal. More "thought" indicated to him that the only method of removing it was to use a nitrate of some kind which would evolve oxygen and oxidize the carbon. Nitrate of soda, therefore, was used and upon its use in German silver he obtained a patent (Nov. 2, 1869). As this material was found to work better with black oxide of manganese, the two afterwards were used together and now constitute the flux of the aforesaid concern.

Personally, I doubt whether this flux has much value, and the fact that it is possible to make good German silver without it would seem to indicate it. I feel quite sure that there is no oxidation of carbon, as nitrate of soda, when allowed to melt on copper, will not oxidize it, but instead will actually render it sounder. It is also a singular fact, which I have already demonstrated in practice, that a mixture of nitrate of soda or the nitrate of potash (nitre), mixed with black oxide of manganese and used as a flux on copper, will actually introduce metallic manganese into the copper, showing that there is a reducing action. This explains, I believe, the reason for the action of the flux. A slight amount of manganese is introduced. This is also borne out by the fact that within the last few years, metallic manganese has come into use as a deoxidizing agent for German silver and similar nickel alloys. Its use is preferable to introducing manganese through the agency of a flux as the results are then positive and certain and pre-determined amounts of manganese always can be added. Its use has been attended with excellent results and it seems to be the natural deoxidizing agent for nickel and nickel alloys.

In making German silver, common salt is used in the same manner and with the same results as those obtained in brass and bronze.

In the melting of washings from the reclaiming of brass foundry ashes, a flux must be used in the majority of instances, unless they have been washed very clean, and this is rarely done. Even with clean washings a flux is advisable. The same rule applies to grindings, skimmings and similar waste materials. Unless a flux is used when they are melted, a union of the particles of metal is prevented by the presence of so much foreign matter, and instead of fluid metal there usually is obtained a small quantity in the bottom of the crucible and a large mass of pasty material fritted together. When a flux is used the foreign matter is dissolved and clean metal is left.

For use in melting brass, bronze or composition washings, grindings, skimmings and similar material, I have found nothing better than plaster of paris. It is a cheap and excellent flux for this purpose. How far back it was employed for this purpose I cannot say, but it was first called to my attention in 1890 by the late C. S. Moore. I believe he can really be called the father of the present scrap metal industry in the United States, as he was responsible for many innovations like the "transmutation" of yellow washings into red, and I firmly believe he was the first to use plaster of Paris as a flux. He informed me to this effect and I have no reason to doubt his word.

Plaster of Paris.

The value of plaster of paris as a flux in melting washings, grindings and similar material is that it possesses the property of dissolving what foreign matter may be present in the shape of sand, slag or oxide, and it has practically no action on the crucible. In addition, it is quite cheap. On account of the fact that it has no action on the crucible, any desired quantity can be used. It melts readily and forms a thin slag.

To melt washings or grindings with plaster of paris, mix about 5 pounds with the washings when they are placed in the crucible. Then melt in the usual manner. If the slag at the conclusion of the melt is not sufficiently fluid, more should be added. When the metal is completely melted pour the entire contents of the crucible into ingot molds. *Do not attempt to skim it.* The slag will run into the molds with the metal and rise to the top. Allow the mass to cool and then dump the ingot molds. The slag of plaster of paris can be readily detached by a blow from the hammer, or it usually will fall off under normal conditions. If desired, it may be used again. It will be found a very satisfactory flux for this purpose.

Plaster of paris is calcium sulphate, and when used as a flux, the action seems to be one of simple solution: The molten plaster dissolves the foreign matter as sugar is dissolved by water

When coal is present in washings, as it usually is, there is a slight reduction of the sulphate to sulphide and there will be an odor of sulphur during the melting. This seems to do no harm and I have never been able to find that it injures the metal. In fact, it appears to act in an opposite manner, and any iron that may be present is changed to sulphide and enters the slag.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Pitted Nickel Castings

We make nickel castings and have had considerable trouble from surface pitting, the small holes being filled with sand. We are using a fine brass sand for the molds, and do not face them. Is there any facing that will withstand the high temperature of nickel?

It will be necessary to use a facing, as these pits are caused by the fusion of the less refractory portions of the sand, which melt and form little globules that are squeezed into the liquid metal by the pressure of the gases generated at the same time, producing a pitted surface on the casting. This trouble was also experienced by early steel founders when they attempted to cast steel in molds made of the sands and facings used for iron molding, and it was found that facings that would peel from iron castings of several tons weight were of no value for even small steel castings. This led to the adoption of more refractory materials for making molds for steel, and facings of ground fire brick and ground crucibles, blended with fire clay and molasses water, were used for years by some concerns before the superior advantages of the silica facings became known. Nickel and steel melt at about the same temperatures, therefore the materials used for making molds for steel will give good results on nickel. The practice in many steel works is to make a facing of silica sand, flour, fire clay and molasses water, and use it next to the patterns, backing up with ordinary heap sand. It is not advisable to do this in a brass foundry where nickel or Monel metal are only occasionally run, because a day's work on nickel, using a silica facing, would ruin the sand pile for future work on brass. It would be better, therefore, to keep one bench, or better still, a tub, entirely for molding for nickel, and fill it with a sand pile having a silica base. It is advisable to get a good grade of silica sand, enough to make the pile, and add sufficient fine fire clay of good quality to give it sufficient bond to make molds. The use of flour is not advisable, as the sand pile would get sour. About 10 parts silica to 1 of fire clay should be sufficient, but this can be determined by rubbing the mixture between the fingers. Use this on the entire mold for making small castings; on heavy castings face as follows: 25 parts of this molding sand; 1 part powdered rosin, wet down with molasses water. Paint or spray the molds with silica wash mixed with molasses water, and dry. All the molds will produce better work if they are dried, either in the oven or merely skin dried with a torch, and never use plumbago either on molds or cores for nickel.

Effect of Manganese on Babbitt Metals

What is the effect of manganese on babbitt metals? We wish to make a manganese babbitt somewhat similar to the well-known nickel babbitt.

Manganese cannot be used in babbitt metals as it is so strongly oxidizable that it makes the alloy mushy. The addition of less than 1 per cent of manganese-copper to a tin bronze will convert 25 per cent of the alloy to a thick, slate-colored mush, which, when plastered into ingot molds, exhibits purple and gold colorings on top.

A few pounds of this mush added to 500 pounds of melted, genuine babbitt metal will cause the latter ingots to surface oxidize at a low temperature, so that it can be poured cool and will assume the rich gold coloring some makers prefer on their ingots.

Improper Gating of Copper Castings

We are making copper castings by the use of silicon-copper, and cannot get them clean, as dirt shows when the scale is machined off. We use ingot copper, with two per cent of silicon-copper, and pour the metal hot. The castings are quite heavy.

The dirt is caused by improper gating, and the fact that there is scale on the castings shows they are being poured too hot. Copper containing silicon is very fluid and does not need to be poured as hot as when zinc is used. It is very similar in casting properties to alloys containing aluminum, and has to enter the mold with extreme quietness to avoid the formation of dross. As we do not know the shape of your castings, it is difficult to advise as to how they should be gated. The following rules, however, can be applied in all cases: The metal should enter the mold at the lowest possible point and should always rise, never drop. The gate at which it enters can be quite small, the heavy portions of the casting being fed by risers, and sometimes the latter will have to be placed directly on the casting, as in the case of steel. A flat heavy slab, for instance, should have the mold steeply inclined, the metal being poured in at the lowest end, so that it gently rolls up hill and into a heavy riser, which feeds the casting and receives any dirt. Never gate such castings with two or more gates in such a manner that the streams of metal impinge. Therefore, change your method of gating and pour the metal cooler.

Cheap Metal for Nickel-Plating

We would like to obtain a mixture of hard white metal with something like the machining qualities of brass but lower in price, and of a composition to take nickel-plating. We use considerable quantities of brass for making acorns for safes, that is, the ornamental tips for the hinges, and we would like to get some material that is cheaper and would still answer the purpose.

A cheap, hard, white metal with the qualities of brass is at present unknown. Most white alloys of this character contain nickel or manganese, or both; with the latter no less than 16 per cent must be present in the alloy to whiten it, which, when manganese-copper, free from iron, is used, makes the cost greater than that of brass. When the alloy is made by using ferro-manganese the iron will be found scattered throughout the alloy in the form of little pellets composed of iron and manganese, which are so intensely hard that a file will not touch them, and although the iron can be removed by the brass founder, it greatly increases the cost of the alloy, as the metal must be remelted several times.

When nickel is used, from 12 to 15 per cent will be required, and one of the cheapest of these alloys contains only 23 per cent of zinc and 5 per cent lead, a total of 28 per cent of cheap white

metals. The balance consists of copper and nickel, the content of the latter being 12 per cent. It will be seen that this alloy is not as cheap as many grades of brass.

The zinc series of alloys are hard, bluish-white metals, and would probably be the best in this case if it were not for the fact that the goods must be plated. An alloy of 87 per cent zinc, 7 per cent copper and 6 per cent tin is very good. An alloy that can be cast in metal molds is lead 87 pounds, antimony 13 pounds, and lead 80 pounds, antimony 15 pounds, tin 5 pounds. We, however, advise the use of a cheap yellow brass for the purpose, and the cheapest mixture that can be used is copper 20 pounds, zinc 16 pounds, lead 2 pounds, aluminum 3 ounces. This metal should be poured at a comparatively low temperature, that is below a flaring heat. It will run freely, and when properly made is very strong as well as easy to machine.

Difficulties with Brass Bushings

We are making brass bushings which develop little clear holes under the surface when they are machined. The mixture we are using consists of 50 pounds of scrap brass, 40 pounds of copper and 10 pounds of zinc.

The metal is a yellow brass containing aluminum, and badly oxidized. The fracture shows it to be full of dross. It is in fact a mechanical mixture of copper-zinc-aluminum and dross, and the latter being more of an earth than a metal, as far as the possession of metallic qualities is concerned, does not bind or cement the particles of metal together, but acts like the parting on a mold, so that the metal possesses no strength, and if bent, the part under torsion exhibits numerous net-like cracks.

The "little clear holes" are merely caused by the exposure of the dross, and the reason they are holes or depressions is because the film of dross is very thin and irregular. The holes that show, having been rather dish-shaped, the turning tool cut into the edges of the dish and the particle of metal that filled the inside then tore out with the chips, as the dross acted as a parting. This is known as "flaking," and is very liable to occur when aluminum is present in brass. The metal is entirely unsuited for making bushings. The scrap brass is evidently yellow brass, and either contains aluminum or alum is added to the melt. If this mixture must be used leave out the aluminum and replace the ten pounds of zinc with five pounds of lead and two pounds of tin. Even then the alloy will run high in zinc for the purpose for which it is used, and we recommend the use of all red scrap brass.

Brass Castings which Draw at the Gate

We are experiencing trouble with brass castings, which draw at the gate. They weigh ½ pound each and are cored out to ⅛ inch in thickness. We have tried both heavy and light gates with the same result. The mixture we use consists of copper 15 pounds, zinc 1 pound, tin 1 pound, lead 2 pounds, the balance being scrap. We would like to make this work from all scrap, as we require clean castings, which are drilled and threaded in five places. Another difficulty is that the metal is too tough for our use.

Everything in this case depends upon the scrap, and it is exceedingly difficult to give intelligent advice without a knowledge of what this is composed. If yellow scrap is being used, the metal being in the form of sheet clippings and pieces of red metal, it will be too tough to machine easily and should be leaded. Add 3 pounds of lead to 100 pounds of metal; if not sufficient, increase slightly. There should be no difficulty in using all scrap, either red or yellow metal. If the scrap is red metal it should contain enough lead to work easily, but if not, add more. The 19 pounds of new metal you have been using in a No. 35 pot has not helped matters any, and can be omitted. Castings as light as this should never draw at the gate, no matter whether red or yellow brass is used, and there must be something radically wrong with the manner in which they are molded. As we have no information regarding your molding methods, we can only advise the use of a larger sprue and runner, to feed the castings.

Metallic Packing

In the February issue of THE FOUNDRY, *page 275, there is given a table of babbitt mixtures. No. 4 in the list, while called a per cent mixture, does not come out right, and the parts added together total 122.75 per cent. I would like a mixture for metallic packing for an engine carrying 250 pounds pressure, as "genuine" babbitt does not hold.*

The percentage of tin was improperly given, and instead of 53.3 per cent it should have read 35.3 per cent. The percentages of copper and antimony are so small that they may be ignored, the alloy practically being 35 per cent tin and 65 per cent lead. This will be too soft for your purpose, and in fact if genuine babbitt does not answer, it is doubtful if any babbitt will, but you might try numbers 8 and 9. We advise the use of "Allan" metal, an alloy of 50 per cent lead and 50 per cent copper. It will be better to purchase the ingot, as you will experience difficulty in making the alloy.

The Sale of Brass Foundry Refuse*

By Jesse L. Jones

EVERY brass foundry produces certain by-products, such as ashes, tailings, skimmings, grindings, turnings, etc. Some foundries try to use certain of their own by-products, but the majority of them have found that it is more economical to sell all such material to the scrap dealer or smelter for the reason that few manufacturing establishments, however large they may be, produce enough of such refuse to warrant the installation of a complete equipment for smelting and refining. Broadly speaking, scrap material may be disposed of in two ways. It may be sold to the scrap metal dealer or it may be shipped to the smelter.

By a scrap metal dealer is meant an individual or a firm that has a yard for the storage and sorting of brass refuse, and perhaps also tumblers for washing ashes, etc., magnetic separators for removing iron and a few crucible furnaces for running down turnings and miscellaneous brass castings into ingot brass. Such a firm may also be an agent for the smelter or if not it may act as a middleman between the brass foundry and the smelter, because all low grade material must of necessity ultimately find its way to the smelter. High grade material such as copper turnings, red brass turnings, yellow brass turnings, miscellaneous scrap castings, etc., can usually be run down in crucible furnaces and disposed of advantageously in the ingot form, hence it may never reach the smelter.

When a brass foundry has an accumulation of copper-bearing material or

*Presented at the Detroit Convention of the American Brass Founders' Association.

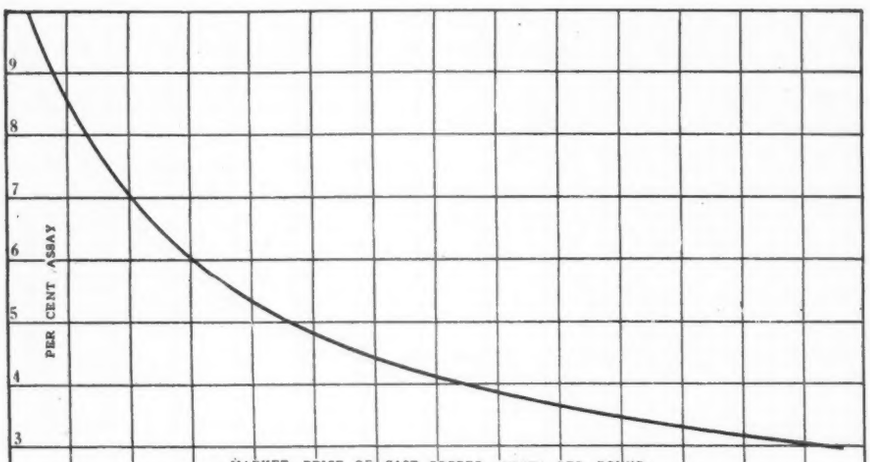
other non-ferrous scrap to dispose of, it is customary for its purchasing agent or secretary to send out a circular letter to the nearest scrap metal dealers, stating the number of lots of material that are for sale, the general character of each lot and requesting that prospective buyers call at their earliest convenience, inspect the material and tender their best prices therefor, f. o. b. cars, on or before a given date. Samples may be sent out if the material is standard stock and uniform in quality. As this is seldom the case, buyers are nearly always asked to take their own samples because this prevents any subsequent claim being set up that the material shipped was not in accordance with the sample.

Sampling by the Dealer.

Every scrap dealer is a law unto himself in the matter of sampling and judging scrap material and every brass foundry is a law unto itself in its manner of grading its waste products. The scrap dealer has to learn the eccentricities of each separate foundry and this information may cost him dearly. As there are no recognized standards of quality for brass ashes, tailings, skimmings, etc., many purchasing agents make persistent efforts to sell refuse that is absolutely worthless. This misguided zeal of sellers and the tendency of the scrap dealers to generalize and judge one foundry by another, leads to frequent misunderstandings and controversies and sometimes an occasional scrap dealer will attempt to safeguard himself in ways that are more ingenious than honest.

One dealer is said to have called at a certain brass foundry for a lot of skimmings and by handing the employe who did the weighing a ten dollar bill, he was given three loads of skimmings and only charged with two loads. The fraud was discovered as a result of an assay of the material which showed that the dealer was paying, month after month, more than the skimmings were worth. Another dealer called for skimmings with a wagon that had a large box under the driver's seat. This was filled with sand before entering the brass foundry yard. The wagon was weighed at the entrance and while driving to the bin where the skimmings were stored, which was at a considerable distance from the scales, a plug in the bottom of the box was loosened by means of a string and the sand allowed to run out. In still another instance the foreman of a large brass foundry was noticed taking "joy rides" with a prominent scrap man and it was found that when the aforesaid prominent scrap man was the successful bidder for the brass foundry's ashes, they assayed over 20 per cent of copper and in one car a dozen of more ingots of copper were discovered carefully covered up. But when some other dealer was the successful bidder the ashes were hand-picked until they were lean.

The majority of scrap dealers, however, are honest and reliable and when the limitations imposed upon them by competitive bidding are taken into consideration, commercial dealings with them are as a rule satisfactory and there are certain advantages to be noted in dealing with them. The small dealer is generally near to the foundry and his freight charges are thus eliminated or very low, so that he can make a close bid while at the same time if he calls for the material with a wagon it does not have to be boxed or barreled. Further, he always expects to pay cash and this fact of getting ready money carries a lot of weight with the average purchasing agent.



CURVE SHOWING MINIMUM COPPER CONTENT THAT WILL WARRANT SHIPPING

By a smelter is meant a firm that has a complete equipment of water-jacketed copper smelting furnaces, cupolas, reverberatory refining furnaces and whatever else is necessary for the handling of all kinds of low grade and high grade material. The number of these firms is constantly increasing and the advantages of disposing of brass foundry refuse to them are many and the disadvantages are few. The smelter takes all classes of copper-bearing scrap and pays for it according to its copper content as determined by sampling and assay. The material may be sampled by the seller before shipping if desired. This need not be done, however, as when the scrap is received by the smelter it is sampled in the customary manner used for ores and three samples taken, one being turned over to the seller's representative, one taken by the smelter and one sealed and kept as a referee sample. The seller's representative also checks up the weight of the shipment as it is unloaded and he sees that a fair sample is taken in the case of material like long copper turnings mixed with steel turnings, which cannot be sampled by quartering, but has to be sampled by selection.

The buyer's and seller's assays should agree very closely and settlement is made on the split assay, after deducting the smelting charge and freight, plus a nominal deduction of 1.3 per cent of the copper content. The price used in each transaction is that given for casting copper in the last issue of the *Engineering and Mining Journal* previous to the date of sale. For high grade material there is no smelting charge.

Minimum Assay of Copper Bearing Material.

In the accompanying illustration is shown a curve which gives the minimum assay that a low grade copper bearing material must contain to warrant shipping it. It holds good for material containing not over 10 per cent of copper. This curve is based on a maximum smelting charge, a rather high freight charge and a high deduction from the market price of copper. The curve shows at a glance the points, dependent on the selling price of copper, where it ceases to pay to ship brass foundry refuse. When it is not profitable to ship such material it may be stored until such time as an advance in the price of copper will warrant its sale. Similar curves may be prepared for material running from 10 to 15 per cent, 15 to 40 per cent, 40 to 50 per cent of copper, etc. Of course the minimum assay to pay expenses is lowered as freight charges, smelting charges, etc., are reduced and it is possible under favorable conditions

to dispose of material running as low as 2 per cent of copper.

Market Value of Scrap.

The above outlined plan is a much more satisfactory and legitimate method of arriving at the market value of scrap than the competitive bidding plan. The seller is sure to receive all that his material is worth and the buyer knows that he will make a fair profit so that there is no unusual incentive for either party to resort to any sharp practices. The methods used by the smelters are accepted without question in the sale of ores of copper, lead, zinc, etc., and when better understood will be accepted just as readily by the brass foundries. One of the valuable features of selling by assay is that it emphasizes the importence of careful grading of all scrap material and not allowing low grade material to be mixed with high grade material. Much of the profit of the small scrap dealer comes from buying miscellaneous lots of scrap that are composed partly of high grade and partly of low grade material at a price that approximates the value of the low grade material. He then carefully grades the material that he has bought and thus realizes a fair profit.

Selling on the Assay Basis.

In selling on an assay basis the importance of keeping cores and heap sand apart from the skimmings and other material that is washed, is obvious. By so doing, tailings may often be stepped up from 3 or 4 per cent of copper to 12 to 14 per cent of copper. By drying the tailings (which may contain as high as 20 per cent of water) and then storing them under cover, their value is further increased. If you ship a 60,000-pound car of tailings which runs 20 per cent of moisture you will pay freight on six tons of water and if the material dries out on the road to its destination you may be suspected of shipping short weight.

Objections to Assay Basis.

There are a few objections that are raised in some quarters to disposing of scrap to the smelter. One is that the small dealer will call for scrap and haul it away without cost to the brass founder, while if he is situated at a distance from the smelter the freight charges may be high. This is offset by the greater net profit that is nearly always obtained when selling on an assay basis and by the smelter's establishing local collecting points, which thus eliminate the freight charges or reduce them materially. The small dealer has to pay cash against bill of lading while in the past the smelters have delayed settlement until all assays have been completed. They are now willing, however, to pay three-quarters of the estimated value of the shipment immediately it is shipped and the remainder promptly on completion of the assay.

Many brass founders are dubious about selling on an assay basis because they are not familiar with the methods of sampling and assaying and the various calculations involved in arriving at the market value of scrap material. If they will devote a little time to the matter, they will find it is not such a formidable undertaking after all and that it will not require many assays to show them exactly what each grade of scrap they produce is worth, provided of course that their manufacturing methods are standard and not subject to frequent changes. On account of the loose and unbusiness-like methods of selling that have prevailed in the past, there is sure to be a steady increase in the number of those who dispose of their wastes on an assay basis. Even the firms that prefer the old methods are safeguarding themselves by having a sufficient number of assays made on all waste products to indicate their value. If the market value of a material is ascertained by having it assayed, competitive bids on it can then be better judged. If they are too high, there may be a "nigger in the wood pile" to be investigated, and if they are too low the scrap can be held over for another month and re-advertised.

Holding Material for High Market.

As a rule the holding of scrap material until a high market is reached is not advisable. The increased freight charges for small lots justifies waiting until a minimum carload is obtained, but further holding of it is not warranted. The brass founder is not in the scrap metal business and if he loses at one time by selling at stated intervals, he will gain at another and find that it evens up in the long run.

In conclusion we may say that every brass founder will find it to his advantage to get in touch with one or more reliable smelters and become familiar with their methods of doing business on an assay basis. He should also have a competent metallurgical chemist examine his by-product and report on their average copper content and market value.

Easy Lessons in Chemistry

By CHARLES VICKERS

THE combination of oxygen with any substance, such a wood, coal or paper, produces a visible effect, known as burning, the progress of which is attended with the total destruction of the substance burned, and the evolution of light and heat, and these visible effects have become so associated with "burning" that it is often difficult to conceive of anything being burned and not produce these effects. However, when metals such as iron and copper combine with oxygen, such manifestations are not seen, but the process is one of burning, just the same.

When iron rusts at ordinary temperatures there are no visible light or heat effects, although a combination of iron and oxygen has taken place. Heat, however, really is given off, but it is carried away by the air, as quickly as it is formed, and cannot be perceived. This combination of iron and oxygen is really slow combustion, the iron being burned, and in the course of time nothing is left but the ashes, familiarly known as rust, and as might be expected from the ease with which it is formed, iron ash or rust, is very widely diffused in nature, and is found in most minerals, the ashes of many plants, and the blood of animals. The red, brown or yellow color of many kinds of molding sands is due to the iron oxides which they contain.

Copper and its alloys do not combine with oxygen as readily as iron, and at ordinary temperatures are very enduring. For this reason bronze is used for statues and in exposed positions on the better class of buildings. When copper is brought to a red heat, however, it combines with oxygen and forms copper oxide or rust. Thus, in burning off the insulation from copper wire, a scale is

formed which is brittle and is easily detached in the shape of fine flakes or powder. This is copper oxide, and if the wire is again heated and allowed to cool, another layer of scale will be formed, and when the wire becomes very thin it will be found to be oxidized all through, and so brittle that it may be broken with ease. It will also be noted that the scales from the heated copper are of two colors, red and black. This is due to the amount of oxygen that has combined with the metal. The black scales contain the largest amount of oxygen, being composed of one atom each of copper and oxygen, while the red contains two atoms of copper to one of oxygen, and is produced when the metal cannot get access to sufficient oxygen to form the black protoxide of copper. It will thus be seen that two layers of scale are formed when the metal is heated, the outside one being black, and containing the largest quantity of oxygen, and the inside one red. Both these layers are easily detached by pounding the copper, and before such copper is melted to make bronze, these scales should always be pounded off, because more scale will be formed during the melting process to make it extremely unwise to add any with the metal if it can be avoided.

It will be seen, therefore, that metals can burn, as well as those substances which give off light and heat. One important difference, however, should be noted, and that is, when wood is burned, the ashes which remain constitute but a very small portion of the original substance, because the greater part has been converted into gaseous bodies, by their combination with oxygen, and have escaped into the atmosphere. The metals, on the other hand, have lost nothing, but have gained in weight, as they have taken oxygen from the air and formed a solid substance, the weight of which has been increased by the added weight of the oxygen with which it is combined.

Determination of Lead in Non-Ferrous Alloys*

By C. P. Karr

THE use of lead in the foundry goes back to the remotest period of human industry. Its general properties are well known and when by intent or carelessness they are violated, the founder soon discovers his mistake without much difficulty; its application within very narrow limits is well understood by all practical metal workers. So important a factor has lead become in every foundry where a diversified range of castings is made that it has been deemed necessary to determine the percentage of that element in any form of alloy in which lead may be present. To accomplish this end chemists have made exhaustive researches to discover assay methods that should be accurate, easily conducted and conclusive. In this paper the methods of assay referred to apply to the alloys into which lead enters in the course of foundry practice rather than to the ores in which lead occurs.

Gravimetric Methods.

Alloys not containing tin may be proceeded with directly for the determination of lead, but if tin be present the alloy is dissolved in nitric acid, evaporated to dryness on the water-bath diluted, allowed to settle, filtered and the filtrate treated with 2 to 3 ccm of H_2SO_4 evaporated until fumes of SO_3 are driven off, cooled, diluted with 20 to 30 ccm. of water, washed with dilute H_2SO_4, or alcohol, or both, dried in the steam bath, precipitate detached from the filter, the paper and the precipitate ignited separately, their ashes united, a drop of nitro-sulphuric acid added, gently dried and re-ignited and weighed as $PbSO_4$, or the precipitate is filtered through a Gooch crucible and dried at 105 degrees Cent. to constant weight.

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Difficulties.

This method has been followed for many years, but is reliable only in the most skillful hands. In the incineration of the paper filter there are two sources of loss, the oxidation and volatilization of lead and the difficulty of reconverting every particle of the lead reduced by the carbon of the filter back to the form of a sulphate. To overcome these difficulties the Gooch crucible is resorted to. Dr. Bollenbach states, however, that this sulphate reaction is not very convincing because the precipitate is soluble in strong nitric acid and he proposed the precipitation of lead as a peroxide in an ammoniacal solution by means of bismuth. In a paper on the volumetric assay of lead, Dr. J. F. Sacher states that the precipitation of lead as lead molybdate offers an advantage over that of the sulphate method as the salt is less soluble in water than the sulphate. In a nitrate solution of an alloy not containing arsenic, arsenates nor phosphoric acid, ammonium molybdate may be used directly as a reagent for the quantitative separation of lead. Jannasch has proposed a gravimetric separation of lead and copper from a nitrate solution by means of the hydrogen peroxide method, of lead from tin and zinc, metals which are of vital importance, and while these methods are of great importance to the research chemist, they are, on account of the difficulties incurred in the ignition for weighing, of limited use in the every-day routine of the foundry.

Lead in Babbitt Metal.

About the best example that can be offered of the importance of the gravimetric method is that of the determination of lead in babbitt metal by Walker and Whitman. Dissolve one-half to one gram of alloy in a 250 cc. beaker with 20 ccm. HCL, $5H_2O$ and add HNO_3 a little at a time until the sample is in complete solution. Evaporate to dryness on a steam bath, add 5 ccm. strong HCL (if sample contains 10 per cent or more lead add 10 ccm. HCL), warm a few minutes, stir in 150 ccm. of 95 per cent alcohol, allow to stand at room temperature for two hours, filter through a Gooch crucible, wash with about 100 ccm. of 95 per cent alcohol, dry crucible in air bath for one hour at 105 degrees Cent. Weigh as PbO_2, add 0.0085 grams to the weight of the precipitate and multiply by 0.74473 to find the weight of metallic lead.

Volumetric Methods.

Numerous methods have been proposed for this determination, the three most prominent are Alexander's molybdic acid method, as modified by Low,

the ferro-cyanide method and the permanganate method.

Alexander's original paper was first published in 1893. Low's modification was published later. He employs a solution of 4.25 grams of the salt to the liter, which if ½ gram be weighed out for the assay, corresponds to 1 ccm. to 1 per cent of lead. Dissolve 0.2 grams of pure lead in HNO_3, evaporate with H_2SO_4, filter off the lead sulphate and wash with dilute H_2SO_4. The sulphate is decomposed with 25 ccm. of strong HCL, add 15 ccm. HCL and 25 ccm. water and saturate with 25 ccm. strong ammonia (sp. gr. 0.90). Finally acidify with strong acetic acid, dilute with 200 ccm. of water, heat to ebullition and titrate.

The ferro-cyanide method is carried out with a lead acetate solution acidified with acetic acid and titrate with a ferro-cyanide solution which contains 10 grams of this salt to the liter, 1 ccm. of solution for a one gram assay corresponds to about 1 per cent of lead. Titrate till a drop taken out with a drop of saturated uranium acetate solution gives a characteristic brown coloring upon a porcelain plate. Low digests the lead sulphate with saturated ammonium carbonate solution to convert the sulphate into a carbonate, cools, filters and dissolves the carbonate in a mixture of 5 ccm. water and titrates. Dr. Bollenbach's method is a modification of the permanganate method but his method is a reversal of all former procedure. In a hot solution of potassium permanganate he adds the lead solution, make alkaline by NaOH, drop by drop to complete discoloration, adds some barium sulphate to facilitate the titration, but his method has recently been studied by Dr. J. F. Sacher, who states that the behavior of $BaSO_4$ towards $KMnO_4$ is completely indifferent and that the method proposed is unreliable.

Molybdate Method.

Dr. Sacher advocates the adoption of the molybdate method, which he modifies as follows: To conduct the titration there is required an ammonium molybdate solution, of which 1 ccm. corresponds to 0.01 gram Pb and a 3 per cent tannin solution. In addition there should be a lead nitrate solution containin 16 grams of Pb $(NO_3)_2$ in water to the liter of which 1 ccm. corresponds exactly to 0.01 gram of Pb and ready for the back titration when necessary. With this solution the rest of the molybdate titration may be quickly controlled. The tannin solution must be freshly prepared as it is not unalterable, a 2 per cent addition of acetic acid will prolong its sensitiveness toward the molybdate solution for one week; alcoholic tannin is more permanent and is suitable as an indicator.

Applied to a bronze alloy, for example, the procedure would be to dissolve about 0.5 grams in from 4 to 5 ccm. of HNO_3 (sp. gr. 1.42) evaporate to dryness, dilute with water in the usual way, filter off the metastannic acid, precipitate the copper with the electric current, or as a sulpho-cyanate, and determine the lead in the filtrate from the neutralized nitrate solution. Add 5 ccm. ammonia, dilute to 100 ccm. with hot water, allow to stand on water bath two to three minutes, add 5 ccm. of 80 per cent acetic acid and titrate hot with ammonium molybdate. The volume of the titrated fluid is carefully measured and the excess in molybdate corresponding to this volume, which occasioned the first yellow coloring with the tannin solution is deducted from the ccm. of molybdate solution found. A concentration below 0.15 per cent Pb is to be avoided, because such a condition makes the end point indistinct.

Colorimetic Method.

In such a case the colorimetric method is preferable. The best results are obtained if the precipitate is allowed to settle on the water bath from two to three hours. To be filtered cold, wash with water till the filtrate shows no more turbidity with the neutral lead solution, dry at 100 degrees Cent., ignite gently after separate incinceration of the filter and weigh ofter cooling as $PbMoO_4$. A large percentage of iron in the alloy interferes with an accurate result. This may be avoided by precipitating the excess of iron as a hydroxide in the presence of acetic acid.

A new and simple volumetric method has recently been proposed by Dr. Rupp, as follows: 20 or 25 ccm. of a half normal solution of potassium cyanide is rinsed into a 100 ccm. flask, mixed with a suitable volume of lead solution (1 to 5 per cent) free from acid. Fill up to the mark, mix thoroughly, filter after five to ten minutes and titrate 50 to 75 ccm. of the filter with one-fourth to one-half normal acid to determine the excess of alkaline cyanide. Use methyl orange as an indicator. If the lead salt solution contains any acid in a free state it is made exactly neutral with dilute NaOH in presence of methyl orange. The foundation equation is $2Cy + Pb = PBCy_2$. The calculation is as follows:

1 Pb = 2 KCy = 2HCL and 0.05178 grams Pb = 1 ccm. N/2KCy = 1 ccm. N/2HCL.

The cyanide solution may be standardized against a pure metallic lead or pure metallic copper in the usual way, using 98 to 99 per cent pure pottassium cyanide. The accuracy of the method is insured by the absence of free acid in the lead solution. For an alloy containing a small amount of lead, say less than 0.15 per cent, the colorimetric method has no rival for accuracy, neatness and despatch. Iron, however, in the ferric state introduces an inaccuracy. The solution should be dilute neutral and a nitrate. The method is based upon the comparative color intensity of two liquids of the same concentration and volume, of an unknown with a known value. This analysis may take place in one of two ways: A known solution of a definite volume and known concentration may be compared with an unknown solution having the same volume, and, if it has the same concentration, it will have the same depth or tint of color that the known solution exhibits. With colored fluids that are stable a series of concentrated solutions may be kept in readiness as a basis of comparison. In the second method, use is made of the fact that two solutions of different volume densities appear to be equally colored if their concentration is inversely proportional to the intensity of their color. In a special colorimetric apparatus the height of the column of the liquid is altered until both have the same intensity of color and calculate the desired concentration from the proportion of the depth of the two columns.

Volumetic Method.

Mix the given lead solution with an excess of sulphide solution and select from a series of similarly treated comparative solutions of various, but of known constitution which has been previously prepared from a pure lead nitrate, the one which appears to have the same color for the same volume. Its concentration will be the same as that of the solution which is being tested. Use a colorimetric apparatus if possible. Dry at 120 degrees Cent. a recrystallized sample of purest merchantable lead nitrate, weigh out 0.0160 grams and dissolve in a measuring flask. Dilute to 1 liter. With the solution (A) containing 0.01 milligrams of Pb per ccm., fill up a burette. In graduated cylinders put 40, 30, 20 and 10 ccm. of this fluid, dilute each to 50 ccm. Prepare in addition four other solutions (B, C. D and E) which contains 0.008, 0.006, 0.004 and 0.002 milligrams of lead per ccm. In one of ten about equally wide and high re-agent glasses place upon a label a mark removed about 3 ccm. from the edge, and indicate exactly the same (measured from the bottom) height in the same

way, in the rest of the nine glasses. Fill up No. 1 with the lead solution to be tested; Nos. 2 to 6 with the comparison solutions A, B, C, D and E. Fill up No. 7 with pure distilled water to the mark. Now, in each of the seven glasses add from three to four drops of colorless, that is 10 per cent ammonium or natrium sulphide solution, shake or stir the fluids thoroughly, compare the colors. In making the comparison hold or place the two vessels against a background of opaque white glass. The examination should take place in a diffused light of uniform illumination. As soon as it is established between which of the concentrations the unknown lead solution lies, then prepare three additional comparison solutions of intermediate concentration, so that the lead constituent of one to the other bears the relation of about 0.0005. Pour this into reagent glasses Nos. 8, 9 and 10 and compare them likewise with the solution of unknown strength. Set their colors (for example, between those of C and D, that is, 0.006 and 0.004 milligrams per ccm.), thus the new solutions have 0.005, 0.0050 and 0.0045 mg. per ccm. Therefore the 27.5, 25 and 22.5 ccm. of the solution A are to be diluted up to 50 ccm. Repeat this until constant results are obtained; the concentration up to 0.0005 mg. of Pb. is exactly determined.

Color Comparison.

If the lead constituent in the given solution rises above 0.01 mg. per ccm., then the sulphide addition causes too great a darkening for the comparison and the fluid is correspondingly diluted. Milligrams of lead should be expressed in ccm. Woudstra states that the method by H_2S is inexact in the presence of Fe. J. M. Wilkie takes exception to the use of a sulphide salt alone as a source of color comparison. He prefers to add a solution of KCy or hydrocyanic acid to the lead solution previously made alkaline with ammonia. Iron present must be in a ferrous state, and ferrous hydroxide must be precipitated under conditions that insure its intimate contact with KCy. Sodium sulphite is used as a reducing agent. The solution to be tested must be colorless before the alkaline sulphite is added. If the solution to be tested is not acid, it is to be acidulated with a few drops of acetic or other acid to a distinctly acid reaction; 1 ccm. of a 10 per cent solution of KCy is then added and finally a considerable excess of ammonia; if colorless add the sulphide. If the iron is present originally in the ferric state add a few drops of N/10 sodium thiosulphate, heat slowly to incipient boiling, allow to stand until the color suddenly bleaches out, then add KCy and NH_4OH as usual.

Centrifugic Method.

In the *Chemiker Zeitung,* Feb. 13, 1909, there was published an account of the centrifugic method used successfully by an Italian chemist in the works of Ansaldo Armstrong & Co., in Cornigliano, Liguria. According to the supposed lead constituent he weighs out from 0.5 to 5 grams of the alloy to be tested, treat with HNO_3 in the same way as in a solution for the determination of lead sulphate, filter off the meta stannic acid, evaporate the filtrate with H_2SO_4 until white fumes appear, cool, dilute with 20 ccm. of water. Use a centrifugal apparatus. The tubes used are granulated somewhat similar to that of a burette. A certain factor dependent upon the weight taken is used in obtaining results. If 2 grams for example have been weighed out and the tube reading is at the twelfth division, then by multiplying this reading by the factor 0.2274 the lead content becomes 2.728 per cent of Pb.

Frank Castek used a phosphorus centrifuge machine and prefers the ammonium molybdate precipitation of lead to that of the sulphate. His conclusion is that applied to ore containing less than 35 per cent, using 1 gram for a determination; the results are concordant but somewhat too high; fourteen tests could be made in five hours.

The Planimetric Method.

The planimetric method of the assay of lead in non-ferrous alloys may safely be described as the latest to arrive among us. It is essentially a microphotographic method. In a non-ferrous alloy containing many ingredients it would be necessary to eliminate tin, copper, antimony and arsenic in the usual manner and reduce the alloy if possible to such a state as to contain but two metallic ingredients, preferably zinc and lead. Obtain a sulphate solution, evaporate to dryness until fumes of SO_3 escape and transfer the same to a porcelain crucible, reduce and ignite to a prill or button of lead, allow to cool, remove the prill, flatten carefully and etch with dilute nitric or sulphocyanic acid and take an enlarged microphotograph of the same. Prepare several standard micro-photographs of lead-zinc alloys or lead alone, or lead and tin, or lead and copper, or lead and antimony, or lead and arsenic with the planimeter in the usual way, measure the lead area shown by the microphotograph and by the method of proportion compare the areas of lead in the unknown compound with the areas of the known compound. To any one familiar with operating a planimeter the method becomes exceedingly fascinating and if the buttons or prills of a known composition are carefully prepared and clearly photographed to scale, the results are accurate and conclusive. The percentage composition is arrived at in the usual way. The proportional area of the known composition is to the percentage of the ingredient known as the proportional area of the required ingredient measured by the planimeter is to its required percentage composition.

Electrolytic Method.

Lead is deposited from a strong nitric acid solution at the anode as PbO_2. To facilitate the deposition, the anode should revolve about 500 revolutions per minute. The current density should be about five amperes and the terminal pressure between three and four volts. After ten minutes, interrupt the current for some seconds in order to accelerate the reduction of the metallic lead separating at the anode and repeat this once again towards the close of the assay. After 30 minutes, test the solution for lead with ammonium sulphide. When the work is finished, shut off the current, dip the anode wire or gauze in hot water and then in alcohol and dry for an hour at 230 degrees Cent. and weigh. The weight of the PbO_2 found is multiplied by 0.066 according to H. J. S. Sand and E. F. Smith, by 0.8643 according at A. Stahler, but by 0.857 according to Hollard and Bertiaux. This discrepancy is due to differences of the thoroughness in the expulsion of the water from the deposit. The question has been carefully studied by H. J. S. Sand. He dried the deposits in a specially contrived drying oven where he could maintain a temperature almost constant between 230 and 240 degrees Cent. It is my conviction that this empirical factor must be established by a series of experiments that apply to the oven itself, and the conditions under which the assay is conducted. By igniting the PbO_2 to PbO as suggested by Treadwell, which can be done if a platinum dish be used as the anodem, this difficulty of drying at a constant temperature may be overcome and with more accurate results. In conclusion the writer would say that the last method is the best of all for rapid, accurate work.

J. J. Kessler, 224 S. Vandeventer avenue, St. Louis, announces that he has succeeded to the business of Kessler & Wiedemann, consulting and analytical chemists.

UNIFORM SPECIFICATIONS FOR CAST IRON

England, Germany and the United States will probably adopt uniform specifications for cast iron --- Discussion of the arbitration test bar

AT THE recent annual meeting of the American Society for Testing Materials held at Atlantic City, the committee on Standard Specifications for Cast Iron and Finished Castings reported at length on the progress that is being made toward the unification of cast iron specifications. At the Copenhagen Congress of the International Society for Testing Materials, a resolution was adopted, providing for the more accurate definition of the quality of pig iron than is possible by the best method of grading by fracture. The committee having this work in charge was instructed to inquire in the various countries as to how far specifications by analysis may be usefully substituted for the present method of grading by fracture. In Germany and America the buying and selling of pig iron by analysis is now generally recognized and adopted, and in England, discussions have been recently held regarding the advisability of bringing English practice into line with that proposed by this resolution.

Unification of Specifications.

The committee also reported that English engineers and manufacturers are at present discussing the problem of specifications for cast iron pipe on the basis of the specifications adopted by the respective testing societies in Germany and America. Regarding the specifications for cast iron in general, it is believed that before the next congress in 1912, which will be held in the United States, uniform specifications will have been reached by the three countries concerned, namely, United States, Germany and England. The committee also reported on the arbitration test bar, as it was recommended by the Congress that each country interested make a series of tests with bars approximately 1¼ inches in diameter and cast under standard conditions, the lengths varying from 6 to 24 inches between supports. A set of nine bars each, for three classes of ordinary gray iron, containing 1.50, 2 and 2.50 per cent silicon was suggested. Tests were to be made in each country to determine the length of bars best designed to give the most satisfactory technical and commercial results.

Arbitration Test Bars.

In accordance with this suggestion, C. D. Mathews submitted a series of tests on cast iron arbitration bars, which are taken from different melts to represent the three grades of cast iron. To insure uniformity, the iron representing each set was first taken from the cupola in a 4-ton ladle, and from this ladle three hand ladles were taken to pour each set. From each set three transverse tests were made on supports 12, 18 and 24 inches apart. Three tensile tests were made from each set for comparison. Considerable variation in strength was found even in iron from the same ladle. A summary of the results by comparing the moduli of rupture, giving the average, lowest and highest for each grade of iron, is given in the accompanying table:

MODULI OF RUPTURE.
(Pounds per Square Inch.)

Silicon.	Span 12 inches.	Span 18 inches.	Span 24 inches.	Remarks.
1.50	47,100	45,600	44,700	Average of 9 bars.
2.00	45,500	43,200	39,700	Average of 9 bars.
2.50	45,200	44,900	44,000	Average of 9 bars.
1.50	43,300	40,700	39,700	Lowest of 9 bars.
2.00	41,200	39,100	37,100	Lowest of 9 bars.
2.50	42,300	39,700	36,300	Lowest of 9 bars.
1.50	54,600	49,900	48,400	Highest of 9 bars.
2.00	51,600	46,500	42,700	Highest of 9 bars.
2.50	48,100	52,400	49,200	Highest of 9 bars.

From these results it will be noted, that while the average tests are fairly uniform, the highest average is shown on the 12-inch span, and the lowest on the 24-inch span, for each of the three grades of iron. Taking the extreme variation, it is seen that the highest values were obtained on the 12-inch span for 1.50 and 2 per cent silicon, and on the 18-inch span for 2.50 per cent silicon; the lowest results were all obtained on the 24-inch span.

This would seem to indicate that a 12-inch bar is too stiff, and a 24-inch bar too weak, for satisfactory or uniform results. The conclusions would therefore be that the length of span best suited for testing the 1¼-inch bar is somewhere between 12 and 24 inches.

With the idea of possibly determining this point, an additional set of 40 bars, 1¼ inches in diameter and 26 inches long were cast from the same mixture of 2 per cent silicon iron, 10 bars each being tested on supports 14, 16, 18 and 20 inches apart.

These results were quite uniform, as is shown in the table below:

MODULI OF RUPTURE.
(Pounds per Square Inch.)

	Span 14 inches.	Span 16 inches.	Span 18 inches.	Span 20 inches.
Average	44,000	43,800	43,800	44,100
Low	42,000	41,500	41,200	41,000
High	46,100	45,100	48,500	48,700

However, Mr. Mathews suggested that it is probable that 16 or 18 inches would prove equally satisfactory and either is preferable to a greater or lesser length. As the tensile tests were all made on pieces of the same section, cast under the same conditions, they offer a reliable means of comparison with the transverse strength at different spans. The results show the following approximate relationship:

Tensile strength = 8.5 times the transverse [strength at 12 inches.
Tensile strength = 13 times the transverse [strength at 18 inches.
Tensile strength = 18 times the transverse [strength at 24 inches.

Variations of about 5 per cent in tensile strength and at least 10 per cent in transverse strength are to be expected.

Cocling of Cast Iron.

Alexander E. Outerbridge Jr. reported on some recent tests of cast iron which he has conducted for the purpose of making observation on the operation of the law of rate of cooling of cast iron in test bars varying but slightly in dimensions. The bars were accurately turned to uniform size and were pulled by a 100,000-pound hydraulic testing machine. It so happened that a number of experimental castings were required which would show very much higher tensile and transverse strengths than if cast from ordinary foundry iron and at the same time should be absolutely free

from brittleness or hard spots in any part of the castings, which were only about ⅜ inch thick in the thinnest portions.

Test Bars.

Twenty-six bars, 1 inch square and 15 inches long, and ¾ inch square and 15 inches long were poured from the same ladle as each casting. The object of making two sizes of test bars, varying only ¼ inch in lateral dimensions, was to approximate as closely as possible the cooling conditions existing in the castings, which varied in thickness. The larger bars were broken transversely in a testing machine, using a 12-inch span. The smaller bars were not subjected to the transverse test. The ratio between the transverse strength of a bar 1 inch square, not machined, tested on a 12-inch span and the tensile strength of the same bar machined is about 1 to 10 with ordinary foundry iron, about 1 to 11 with stronger iron, and about 1 to 12 with very strong iron.

Strength of Small and Large Bars Compared.

There was a prevailing uniformity of tensile strength of different bars of the same dimensions cast from one ladle. Invariably the smaller test bars, those ¾ inch square, showed higher tensile strength than the larger bars, 1 inch square, cast from the same ladle. In machining the test bars it was observed that the chips from the bars of the stronger metal, instead of breaking off "short" like ordinary cast iron, were quite "curly," similar to soft steel, or wrought iron turnings. In all cases, with one exception, the metal of the castings in the thinnest section was entirely free from chill or mottled iron and was readily machined. In the one instance the metal was perfectly gray in the test bars and in the castings themselves, except in the thinnest portions, where it was almost white, due to the more rapid cooling of these very thin walls.

The series of tests show that the minimum increase in the average tensile strength of the two test bars, ¾ inch square, over the average tensile strength of the two bars 1 inch square, cast from the same ladle and turned to the same diameter, is 2,250 pounds per square inch. The maximum increase under like conditions was 7,500 pounds per square inch. Mr. Outerbridge concludes as follows: "It is certainly remarkable that differences so large should occur between bars differing so little in dimensions, cast from one ladle and presumably of a uniform mixture of iron. It shows how very sensitive the metal is to cooling influences and again reveals the importance of standard sizes of bars for tests of cast iron."

Car Wheels.

Thomas D. West presented an interesting paper entitled "Unevenly Chilled and Untrue Car Wheels," which is in part as follows:

An uneven depth of chill around car wheels is a serious evil. It weakens a wheel just as a similar defect weakens chilled rolls, and rolls often snap in two under loads that would have had little effect on them were they chilled to an even depth. The chief cause of this weakness lies in the great difference in strength and contraction of the same iron when in a gray state and in the chilled form. First, as to the question of strength. Of two casts from the same ladle, the one gray and the other chilled or of an all white fracture, which means that the carbon is almost entirely in the combined form, the latter generally possesses but little over half the strength of the former. The strength of the white or chilled iron varies according to the class of iron used, that coming from a burnt or oxidized iron being the weakest and that from charcoal iron the strongest. As far as the strength is concerned, therefore, compelling the iron to take the white or chilled form is a necessary evil and often a serious one, especially if the depth of chill is uneven, as it is in the great majority of car wheels cast today.

Secondly, in considering the relative contraction of chilled and gray iron cast from the same ladle of metal, we find that the former contracts about as much again as the latter.

Recognizing the importance of tests on the roundness of tread of chilled car wheels, Mr. West succeeded in obtaining data upon such tests through the courtesies of S. K. Dickerson, assistant superintendent of motive power, and H. E. Smith, engineer of tests, of the Lake Shore & Michigan Southern Railway Co.

To make these tests six pairs of wheels, cast by different founders, were selected. An axle with a wheel pressed on each end was placed in a lathe, and the centers were firmly pressed. The wheels were then hand-turned. The tread was divided into eight sections, each the same distance from the flat edge, and a specially constructed micrometer used to discover any variation in the roundness. All the testing was done with great care and precision. The tests demonstrated the irregularity in the roundness of the chilled car wheels, some of them being out of true as much as 0.043 inch.

The results of a majority of these tests certainly demonstrate the necessity of improvement in the roundness of wheels as well as obtaining an even depth of chill, and show the importance of testing the roundness of car wheels. Mr. West is not aware of any regular tests of this kind being made by the railroads, but believes that if they were made with the present make of wheels, only a very small percentage would pass satisfactorily. Such tests could readily and cheaply be made before the wheels are bored by setting an internally-turned iron ring over the tread. There are, of course, other plans which could be used, but the ring should answer the purpose in many cases.

While the wheels are undoubtedly weakened by the uneven depth of chill and have, therefore, a shorter life, their lack of roundness also prevents smooth running and must cause some vibration or pounding, which greatly aids in creating fractures or breaks in the rails. This pounding effect of flat wheels has been accurately and scientifically demonstrated.

Another fact which was brought out in the experiments, and one which is known or fully realized by very few, if any, experienced car wheel makers, is that the chiller will expand about ¼ inch in diameter after pouring the metal. Here is a movement which is the opposite of contraction and which in the case of the compression chiller, serves to pull the arms back from the contracting crust more than their expansion can force them upward. This evidently defeats the purpose of having arms tightly hug the contracting crust, which is necessary to obtain an even depth of chill and true roundness in wheels.

Power for Foundry Equipment

IT IS well known that in fitting motor drives to machine tools, there is a strong tendency to install too large a motor. This arises from the fact that the power requirements of the machine are seldom known with any degree of accuracy and the power necessary is often guessed at and then a liberal allowance added in order to be on the safe side. This results in considerable loss in efficiency because the ordinary motor is most efficient at or near its designed full load. It often occurs also, that the power required to drive a machine changes with the character of work done and the methods employed, so that a motor which was at one time the proper size may now, under different conditions, be either too large or too small. Determination of the power actually required or delivered by the motor by simple volt-meter and ammeter readings is a comparatively easy matter and where electric drive is used, motors can be changed without much trouble and tests often show that changes would be desirable and would promote efficiency. The following changes were made as a re-

sult of volt-ammeter tests of the electric driven tools in a large foundry:

One 40-horsepower, six-pole motor, rated at 975 revolutions per minute light, and 840 revolutions per minute loaded, driving a Roots blower, one hour after starting took 26 kilowatts. A 35-horsepower motor was substituted for this motor at 900 revolutions per minute.

One 5-horsepower motor, 1,200 revolutions per minute, driving a sand mixer, when running light took 0.92 kilowatts, and when running loaded 1.84 kilowatts. This motor was replaced by a 4-horsepower alternating current motor at 1,200 revolutions per minute.

One 7-horsepower motor, running at 950 revolutions per minute, driving a suction fan for rattlers, with usual load, took 2.86 kilowatts. The motor was replaced by a 5-horsepower motor running at 1,800 revolutions per minute.

One 30-horsepower motor, running at 650 revolutions per minute, driving a line shaft and three rattlers, light, took 2.2 kilowatts, driving one rattler loaded 3.5 kilowatts. The motor was replaced by a 7.5-horsepower motor running at 1,200 revolutions per minute.

One 2.5-horsepower motor, rated speed 1,620 revolutions per minute, driving a double grinder, with grinder idle took 0.68 kilowatts, with two men grinding light castings, it took from 1.1 to 1.8 kilowatts. A 2-horsepower motor was substituted at 1,800 revolutions per minute.

One 2-horsepower motor, running at 1,280 revolutions per minute, driving a 36-inch exhaust fan, removing gases from core room and ovens, with normal load, took 1.8 kilowatts. It was replaced by a 3-horsepower motor running at 1,800 revolutions per minute.

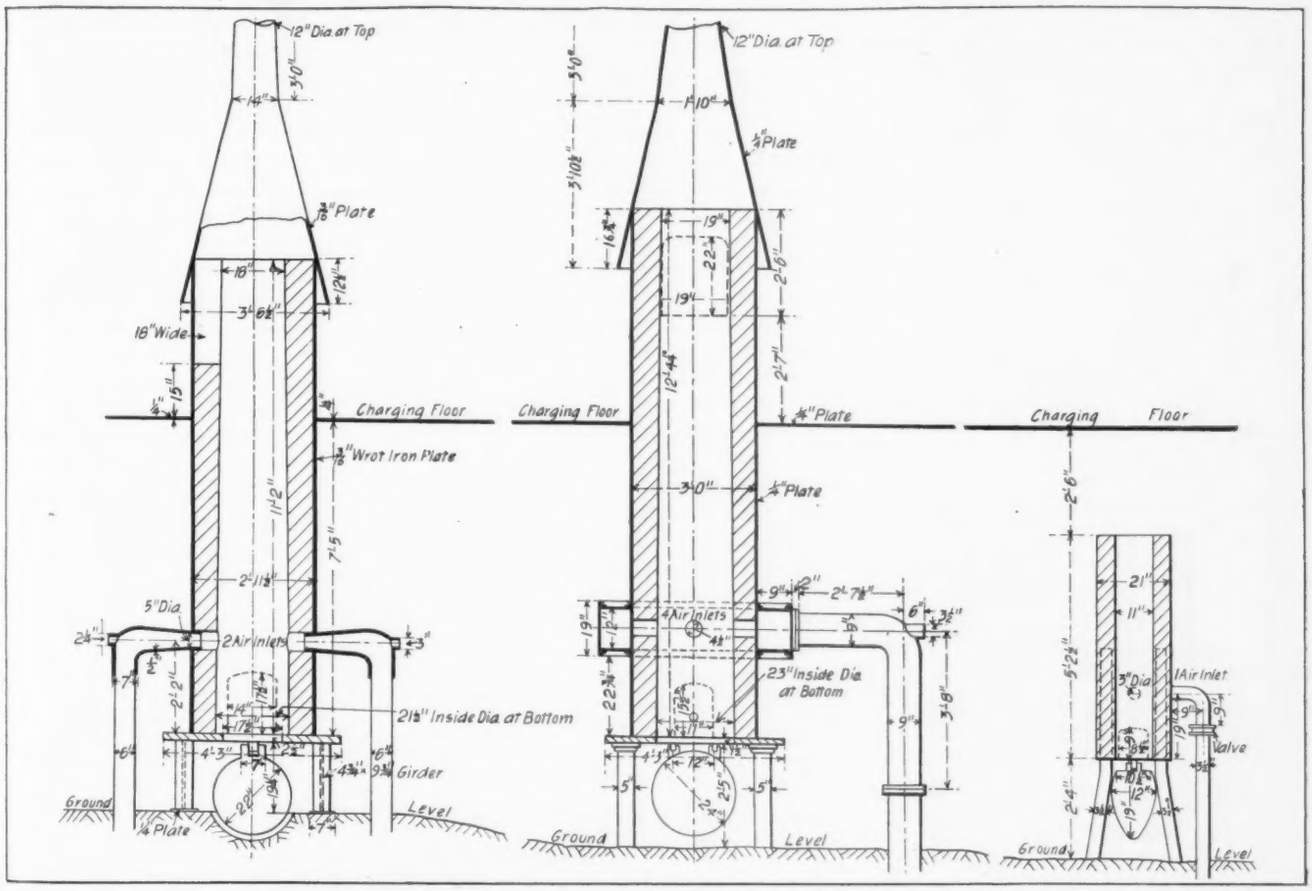
One 2.5-horsepower motor at 1,800 revolutions per minute, driving a 36-inch band saw, a 14-inch bench saw, and a 7-inch lathe, showed the following conditions: Motor driving shaft light took 0.66 kilowatts; driving band saw on 2-inch pine stock, took 1.1 kilowatts; driving band saw, with 2-inch plank on bench saw, took 3.3 kilowatts. This load was so excessive that motor speed was reduced to 70 per cent of normal. The motor was replaced by a 5-horsepower motor at 1,800 revolutions per minute.

The original motors were all of the direct current type designed to operate on a 500-volt circuit; the new machines were all three-phase, alternating current motors wound for 550 volts.

Small Cupolas in South Africa

By W. J. Keep

Question:—Sectional views of three of our cupolas, which are of very small capacity, are shown in the accompanying illustration. In Cape Town, where our foundry is located, Scotch foundry coke costs us $20 per short ton. Our fuel consumption is unusually high, the minimum ratio being 3¾ pounds of finished castings per pound of coke used. We obtain our blast from a fan, 5 feet in diameter, which operates at 1,100 revolutions per minute. We only operate the very small furnace when we desire two or three hundred pounds of castings for immediate shipment.



SECTIONAL VIEWS OF THREE CUPOLAS IN A CAPE TOWN (SOUTH AFRICA) FOUNDRY

Answer:—Your melting ratio is by no means excessive for such small cupolas, as one is 21 inches inside diameter, the other 20 inches, and the third, 11 inches. The amount of fuel required for melting iron in cupolas of such small capacity is necessarily high, and it is doubtful whether the melting ratio could be materially improved.

John H. Patterson, president of the National Cash Register Co., Dayton, O., has returned from a two years' trip to Europe.

THE FOUNDRY

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Trade Outlook

In several branches of the foundry industry, demand is restricted, and the melt has been further curtailed by the torrid weather, which has prevailed throughout the country. The production of castings for the automobile trade has shown a marked falling off, although large contracts are being placed for next season's requirements. Steel foundries are still engaged on contracts placed by the railroads earlier in the year, but these interests are now buying sparingly and little new business is being placed. On the whole, however, the foundry output can be considered normal for this season of the year. The tremendous increase in producing capacity during the last 12 months is a factor that must be weighed when making comparisons of the percentages of operating capacities, as a shop, which a year ago was fully engaged, may now be working at only 80 per cent, and yet will produce a larger tonnage, owing to extensions made during the year. In addition, many new plants have been established, which has led to a further division of tonnage. On the Pacific coast, the outlook in the foundry trade is better than it has been at any time during the last two years. Most of the jobbing foundries in that section are well filled with orders and all of the manufacturing plants are operating up to their capacity. Extensive improvements and additions are being made to municipal and private water systems in the west, requiring a large tonnage of cast iron pipe and connections. In all centers, foundry iron values have declined, and quotations are as follows: No. 2, Chicago, $16.50; No. 2 southern, Cincinnati, $14.75; No. 2, Birmingham, $11.50; No. 2, Cleveland, $14.00; No. 2, Pittsburg, $14.25; No. 2, Philadelphia, $16.25; basic, eastern Pennsylvania, $15.75; basic, Valley furnace, $14.50. Copper has declined to 12.25 cents, but tin has advanced to 33.25 cents.

Personal

Thomas D. West, Cleveland, will spend the month of August at Lake Placid, N. Y.

Robert Montgomery, of the William Penn Silica Works, William Penn P. O., Montgomery county, Pa., has taken his son, Robert G. Montgomery, into the firm.

Walter B. Snow, publicity engineer, Boston, has added to his staff, H. Ross Callaway, late assistant to the mechanical engineer of the New York Edison Co.

W. E. Crist, formerly president and general manager of the Crist Valve Mfg. Co., has been appointed general manager of the valve department of the O. M. Edwards Co., Syracuse, N. Y.

W. G. Jones, formerly in charge of the brass foundry of the Lowell Machine Shop, Lowell, Mass., has taken charge of the new aluminum foundry of the Fairview Foundry Co., Detroit.

Thomas H. Mirkil Jr., formerly general manager of the Southwark Foundry & Machine Co., Philadelphia, is now general manager of the Poole Engineering & Foundry Co., Baltimore.

W. M. Scott, formerly with the Hayden Saddlery Hardware Co., Columbus, O., has been appointed general superintendent of the new foundry that is being built by the C. W. Raymond Co., Dayton, O.

William J. Keep sailed for Europe on the steamer Celtic, Saturday, July 16. While abroad Mr. Keep will attend the meeting of mechanical engineers, which will be held at Birmingham and London. He does not expect to return before Oct. 1.

C. F. Gaywood, formerly manager of the Phosphor Bronze Co., Birmingham, England, is now associated with the firm of Chas. Glifford & Son, Ltd., of the same place, and will take charge of a new phosphor bronze department that will be established by this concern.

Prof. John Jermain Porter, metallurgical engineer, in addition to his duties at the University of Cincinnati, Cincinnati, is prepared to make investigations on efficiency of raw materials, plant and operation. Prof. Porter has made a special study of cast iron, and in addition, has had a wide experience in the operation of blast furnaces.

U. E. Kanavel, treasurer and general manager of the Interstate Sand Co., Zanesville, O., has resigned. Mr. Kanavel has had a wide experience in the mining and shipping of molding sand, having become connected with the Ayers Mineral Co., Zanesville, in 1888, and he remained with this concern until the organization of the Interstate Sand Co. in 1905. Mr. Kanavel's present address is 1462 East 109th street, Cleveland.

Aeroplane Castings

An English, patented alloy for making light castings for automobiles and aeroplanes consists of:

70 to 90 parts Aluminum
18 to 5 parts Magnesium
12 to 2 parts Cadmium

It is recommended for ornamental work in place of electroplated ware and for bells, gongs and carriage fittings.

MODERN EQUIPMENT FOR THE FOUNDRY

High pressure sand blast --- Combination shockless jarring and roll-over molding machine --- Core ovens heated with producer gas --- Automatic grinding and polishing machine

IN THE Kelly high-pressure sand blast machine, shown in the accompanying illustrations, the erosion of the inner surface of the nozzle is obviated by the use of a nozzle of a special type and separate lines of hose for the sand and compressed air. It is claimed that it will steadily maintain any reasonable pressure, but the best results are obtained by employing a pressure of about 100 pounds per square inch. In this machine the air pressure is brought to bear at the point where the sand is ejected, and it is further accelerated through a high-pressure jet, which gives it added efficiency. The volume of air consumed is under control at all times, since no more air can escape through the high-velocity jet than will flow through a given orifice at a given pressure. This is especially important, since the sand enlarges the orifices of the nozzles generally used, resulting in the increased escapement of air, with a consequent reduction of pressure efficiency. The sand hose carries a mixture of sand and air at a low velocity, and feeds it into the high-velocity jet. The combined jet of air and sand then passes out through the end of the nozzle, which has a ¼-inch orifice, at a high pressure.

A sectional view of the nozzle is illustrated in Fig. 3, and it will be noted that the parts exposed to wear are protected by removable tips. One tip is used in the nozzle at the point where the sand passes from the sand hose, and another tip is located in the end of the nozzle. These tips are inexpensive, and can be readily replaced when worn.

The method of removing paint and rust from a steel door by one of these machines is shown in Fig. 1, and Fig. 2 is a sectional view of this sand blast tank. By reason of the high pressure possible, the Kelly machine has broadened the use for which the sand blast is employed in foundries and steel works. In some of the large steel foundries in the Pittsburg district it is replacing pneumatic chippers for removing the burnt sand from steel castings, and it is claimed that one machine will do the work of four pneumatic chippers. Furthermore, it can be used to advantage in cleaning nickel and carbon steel ingots, eliminating the pickling operation, since it removes the hard mill scale, and exposes any imperfections. Two of these machines have a capacity for cleaning 200 ingots in ten hours.

This sand blast device is also serviceable in cleaning the bottoms and interiors of steel ships, and one large oil company is using this apparatus for cleaning its oil tank ships. Among the concerns now using the Kelly sand blast are the following: New York Division of the New York Central & Hudson River Railroad, for cleaning steel bridges and steel cars; Jones & Laughlin Steel Co., Pittsburg; American Steel Foundries, Chicago; Pressed Steel Car Co., Pittsburg; Crucible Steel Co. of America, Pittsburg; Isaac G. Johnson & Co., Spuyten Duyvil, N. Y.; United States Sanitary Mfg. Co., Pittsburg, and the Standard Oil Co.

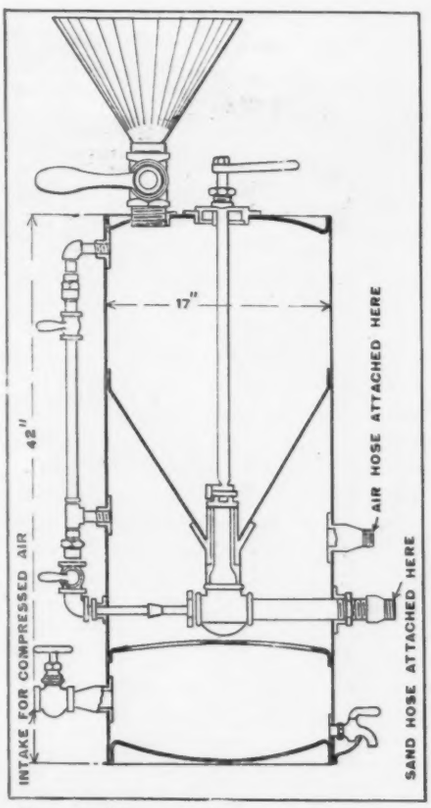

FIG. 2—SECTIONAL ELEVATION OF SAND BLAST TANK

FIG. 1—CLEANING A STEEL DOOR WITH THE KELLY HIGH-PRESSURE SAND BLAST

This sand blast is manufactured by the High Pressure Sand Blast Co., 20 Broad street, New York City.

Molding Sand Tariffs

Announcement has been made of an increase in freight rates on molding sand by the railroad companies composing the Central Freight Association and the Western Trunk Line Association, effective Aug. 1, or later. A protest against this advance has been made by ten large miners and shippers of molding sand in the central west. The protest is in part as follows:

"In addition to the injustice of any

increase in rates, the prime cause of this protest at this time is that, we together with other sand miners and dealers are bound by contracts to furnish sand delivered to the customer at prices based on the existing freight rates and a change at this time would work a very great hardship. It will be a physical impossibility to load the requirements of our customers prior to Aug. 1, 1910, or any other date sooner than Jan. 1, 1911. If any increase is contemplated, it should become effective during the months of January or February, 1911."

The protest is signed by the following concerns: Ayers Mineral Co., Zanesville, O.; Bradford Sand Mining Co., Centerton, Ind.; L. K. Brown, Zanesville, O.; Central Silica Co., Zanesville, O.; Garden City Sand Co., Chicago; Interstate Sand Co., Zanesville, O.; Newport Sand Bank Co., Newport, Ky.; Ohio Sand Co., Conneaut, O.; Ed. E. Squier Co., St. Louis; Standard Sand & Machine Co., Cleveland.

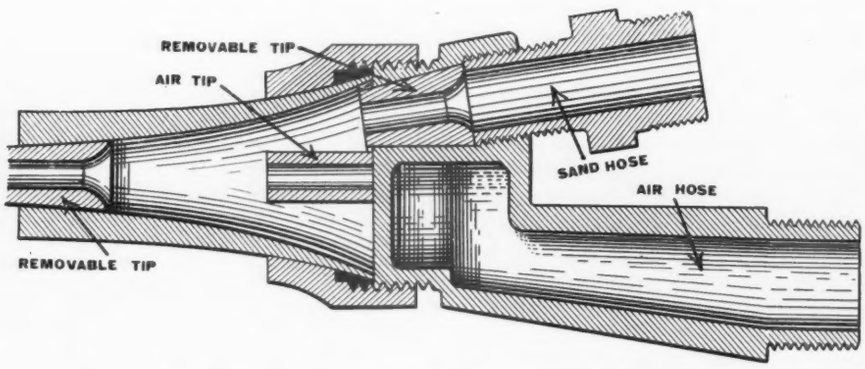

FIG. 3—CROSS-SECTION OF THE KELLY SAND BLAST NOZZLE

Jarring and Roll-over Molding Machine

A combination 6-inch shockless jarring machine and a 30-inch roll-over machine, provided with a 12-inch pattern-drawing cylinder, and having a 12-inch straight draft, is illustrated in Figs. 1 and 2. The flask clamped to the pattern plate, resting on the jarring table with the bottom board clamped on ready to be rolled over, is shown in Fig. 1. Compressed air is then admitted to the roll-over cylinder, the arms of the hinged frame are brought up in contact with the pattern plate, and the flask is raised clear of the jarring table by the continued movement of the hinged frame. When the limit of straight movement has been reached, and the flask begins to roll over, an eccentric on the trunnion shaft actuates locking bolts, which secure the pattern plate to the hinged frame and hold it firmly when inverted. The flask is then lowered into the receiving cradle, which adjusts itself to the inequalities of the pattern board, and when the weight has been taken by this cradle, clamps holding the flask to the pattern plate are removed and the pattern is ready to be drawn.

In Fig. 2, the pattern has been drawn and has been rolled back onto the table of the shockless jarring machine in position to receive another flask. It will be noted that ample space has been provided between the hinged frame and the pattern plate in this position, so that during the operation of jarring, the hinged frame and every part of the machine, with the exception of the jarring table and its anvil, are free from shock.

When the flask has been filled with sand and heaped up to allow for settlement in jarring, the starting valve is depressed, and the jarring action continues automatically, until it is released. The latch lever at the left of the operating stand, Fig. 1, regulates the stroke, which can be varied from 1 to 4 inches, while the mold is being rammed.

In this way, it is possible to take a few short strokes until the air imprisoned in the sand has been driven out, after which the stroke is increased, and more effective work can be done in a shorter time. The receiving table is adjusted by the hand wheel on the operating stand. This machine is built by the Tabor Mfg. Co., Philadelphia.

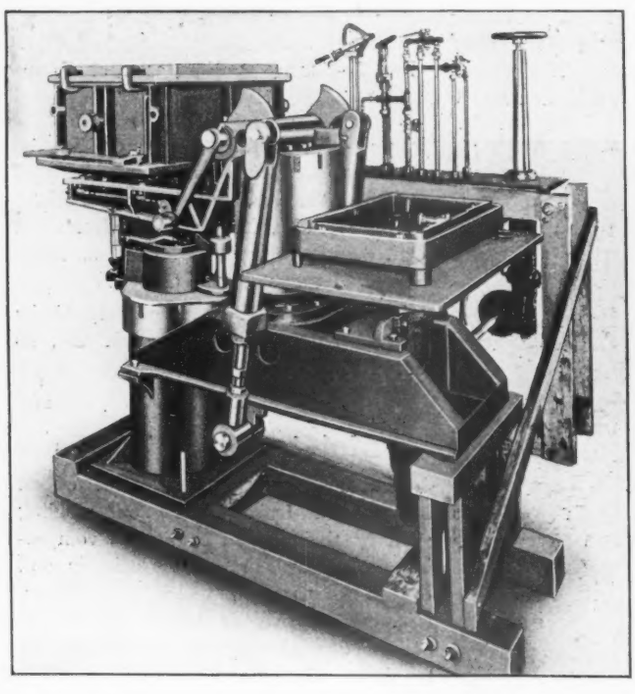

FIG. 1—COMBINATION JARRING AND ROLL-OVER MOLDING MACHINE, SHOWING FLASK ON JARRING TABLE

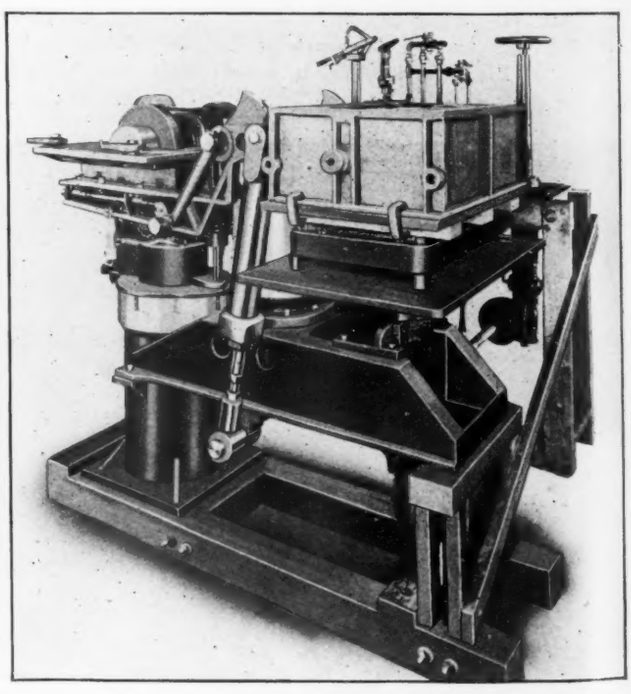

FIG. 2—FLASK ROLLED OVER AND PATTERN DRAWN. THE PATTERN PLATE IS ON THE JARRING TABLE

Producer Gas Core Ovens

An economical system of heating core ovens with producer gas is being installed in British foundries by R. & G. Hislop, Paisley, Eng. This concern claims the use of producer gas for this purpose effects a saving over coke firing of from 20 to 50 per cent, and, as the temperature of the ovens ranges up to 1,200 degrees Fahr., they bake more quickly, thus turning out more work in the same time and space, the heat being applied so evenly that the cores are dried without cracking.

Fig. 1 shows an installation at the works of Marshall Sons & Co., Gainsborough, Eng., Fig. 2 being a plan of the same. There were originally only two core ovens, *B* and *C*, Fig. 2, and their combined capacity was 160 cubic yards. These were formerly heated with coke, at a total weekly cost for fuel and labor of 10 cents per cubic yard.

It was decided to experiment to reduce this cost and oven *A*, Fig. 2, was built for the purpose, the other oven being run with coke as usual. The capacity of the new oven was 97 cubic yards and a consumption of 784 pounds of coke every 24 hours generated sufficient gas to run the oven. The labor cost was also reduced, as it required no night attendance, the producer being filled at 6 a. m. and 5 p. m., and the total cost of operation per week was a little over 6 cents per cubic yard.

Another gas producer was installed for ovens *B* and *C*, which were at the same time enlarged to a total capacity of 323 cubic yards. The two producers heating the three ovens consumed 12,937 pounds of gas coke per week, the cost of operation, labor included, being a little less than 5 cents per cubic yard per week.

This was more economical than the experimental oven, and was due to the fact that the first producer was too large and did not work to its full capacity, whereas the two producers were kept busy by the three ovens. The ovens are equipped with asbestos lift doors, which are extremely light and can be easily operated. They conserve the heat, do not buckle, and are tighter and last longer than many other types of doors.

Fig. 3 is another view of the oven, the asbestos doors being clearly shown. To test the temperature they were filled with green cores and closed down at 6:30 p. m. and at 10:00 p. m., the heat at the end of the oven, where the hot gases entered, was 520 degrees Fahr., the center near the top of the stove was 550 degrees Fahr., and the end, where the gases pass out to the chimney, 280 degrees Fahr. The temperature of the gases at the entrance and exit was obtained by passing thermometers through the asbestos screen. They were at first inserted with the bulbs 3 feet 6 inches from the screen, and they were moved several times, until finally they were 4 feet 9 inches from the screen. No change in temperature was observable as the thermometers were moved. The observations at the center of the ovens were taken and showed that the temperature remained almost constant.

FIG. 1—CORE OVEN INSTALLATION AT THE WORKS OF MARSHALL SONS & CO.

Good Practice?

By W. J. Keep

Question:—We charged a 22-inch cupola with a coke bed of 200 pounds and 400 pounds of iron. The second charge consisted of 40 pounds of coke and 200 pounds of iron, and so on for nine charges. The blast pressure was 2 ounces. The tuyeres began to block and the furnace was run down and the bottom dropped. Would it have been wise to have continued running? (This

was in the foundry of a trade school.)

Answer:—The bed was not large enough, and the coke charges were too large. The trouble was that the fire was not lighted early enough. Light two hours before you want iron. Use enough wood to light the coke, and then fill in coke 2 feet above the tuyeres, and let it burn with the tap hole, slag hole and tuyeres open for one hour with natural draft. Then measure and see if the coke is 15 inches above the top of the tuyeres. If not, add enough to make it so. If it is above that, do not use as much coke next time. Charge iron and coke until the cupola is full. Use only 30 pounds of coke for each charge and later on reduce it to 25 pounds if the iron is hot. Let the fire continue to burn 15 minutes before you want iron, put on blast, close the tuyeres and slag hole, and when the iron runs out of the tap hole, see that the hole is hot enough not to chill the iron. Then stop it up and let the iron accumulate until ready to tap out. You must have plenty of tuyere area. Six tuyeres, 6 inches high and 4 inches wide, are recommended, and your blast pipe should not be less than 7 inches in diameter. The blast pressure should not be less than 6 ounces. Tap out slag after the fourth charge. The cupola must be hot enough to melt iron, and the iron must be ready to melt before the blast is put on. Your trouble was too small a bed, too cold a cupola and too light a blast.

The office of Nash, Isham & Co. is now located in the new Liberty Tower building, 55 Liberty street, New York City.

Trade Notes

The firm of Kessler & Wiedemann, chemical engineers, St. Louis, has dissolved partnership. H. E. Wiedemann is now located in the Holland building, St. Louis.

The Cleveland Crane & Engineering Co., Wickliffe, near Cleveland, O., is erecting a large addition to its plant and has installed considerable new machinery.

The Atlanta Foundry & Machinery Co., Atlanta, Ga., and the Southern Iron & Equipment Co., of the same city, have recently increased their melting equipment by the installation of Newten cupolas.

The Dalton Foundry & Machine Co., Atlanta, Ga., and the Southern Iron & Equipment Co., of the same city, have recently added to their cupola equipment, installing Newten cupolas in both cases.

The Bessemer Gas Engine Co., Grove City, Pa., recently installed three electric traveling cranes, two of 5 tons capacity and one of 25 tons capacity, which were furnished by the

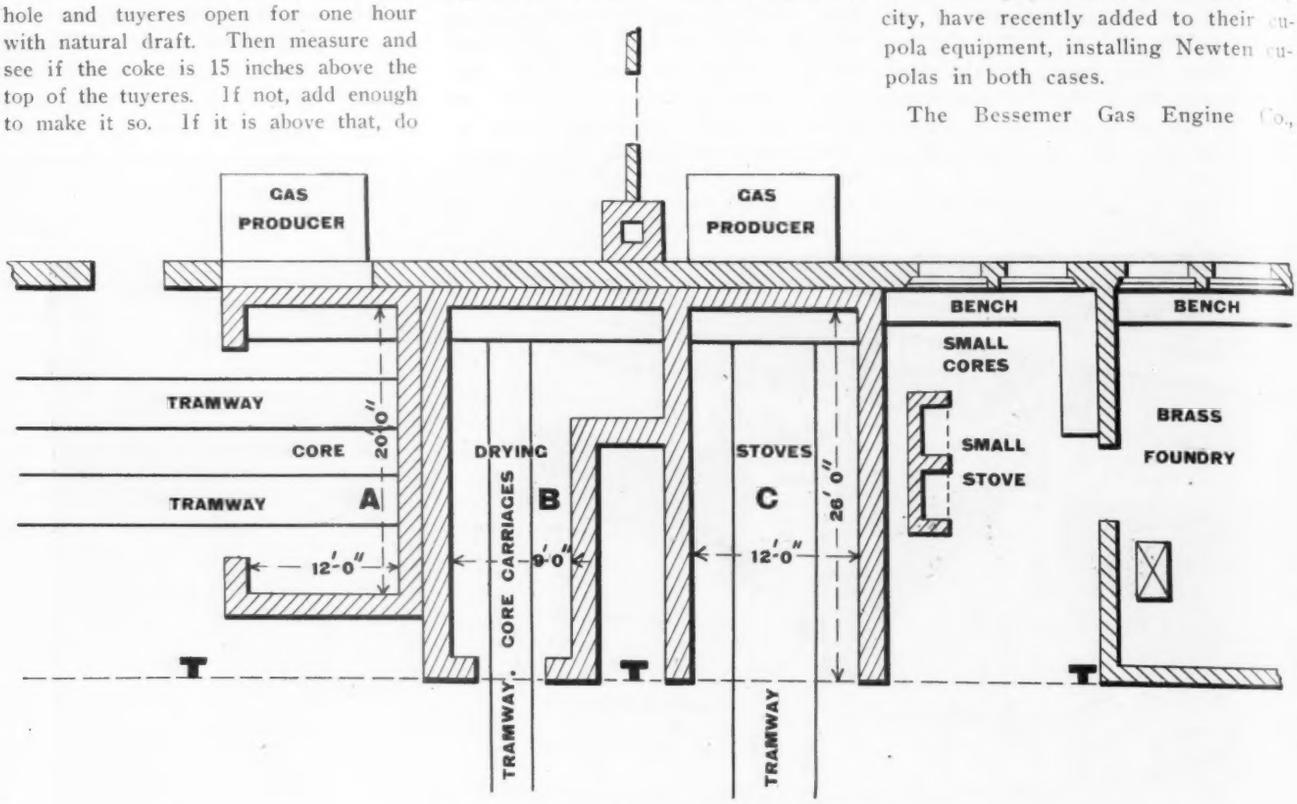

FIG. 2—PLAN VIEW OF CORE OVEN INSTALLATION

FIG. 3—VIEW OF CORE OVENS, SHOWING ASBESTOS DOORS

Northern Engineering Works, Detroit.

Sylvester S. Howell has become associated with Paul M. Chamberlain, engineer, Marquette building, Chicago, under the firm name of Chamberlain & Howell. This concern will carry on the general designing and consulting engineering practice established by Mr. Chamberlain.

At a meeting of the stockholders of the Newport Sand Bank Co., Newport, Ky., Cleveland H. Dye was elected a director to succeed J. F. Dye, deceased. Officers were elected as follows: Geo. W. Dye, president and treasurer, to succeed J. F. Dye, and Cleveland H. Dye, secretary.

pearance the publication could not be improved.

A convention of branch office managers and salesmen of the B. F. Sturtevant Co., Hyde Park, Mass., was held June 15 to 18 at the works of this concern. Four days were spent in discussing affairs relating to the business of the company and the evenings were enlightened by banquets and other social features. On the last day of the convention E. M. Foss, treasurer of the B. F. Sturtevant Co., entertained the salesmen and managers at his beautiful Cohassett home. The convention was marked by great enthusiasm as the company

AUTOMATIC GRINDING AND POLISHING MACHINE

The Anthony Co., 45 West Thirty-fourth street, New York City, has issued several bulletins describing its crucible fuel oil melting furnace, equipped with a Nebulyte low-pressure burner. High-pressure burners of this type are also described, which are adapted for steam boiler work. These bulletins are furnished in a loose leaf binder, in which additional announcements, made from time to time by this concern, can be inserted.

"The Merry Molder" is a new publication, issued once a month for foundrymen by the Osborn Mfg. Co., Cleveland. In the first number, the publisher states that it is a mixture of good sense, good humor and a little advertising. The contents are entirely in accord with this announcement, as the text matter is exceedingly well-prepared and well-selected. In typographical appearance the publication could not be improved.

rounded out the largest business year in its history on July 1.

Automatic Grinder

The automatic grinding and polishing machine, shown in the accompanying illustration, has been designed by the Excelsior Tool & Machine Co., East St. Louis, Ill., for grinding or polishing flat or semi-flat castings, such as stove tops, stove trimmings or hardware of any kind, having no abrupt irregularities. It is not claimed that this machine will finish all stove castings, but it is stated that it will finish the greater portion of these sections, and by slightly altering some of the patterns to accommodate the machine, very little hand work will be required. The machine is so constructed that the downward limit of the wheels, as well as the pressure of the wheels on the work, can be adjusted while the machine is in operation.

It is built on the double arm principle to polish on both sides. This feature was adopted to secure rigidity, thereby balancing all moving parts, and to return the finished work to the starting point, permitting one operator to readily take care of one or more machines. The use of follow-boards is obviated by the boards to which the castings are attached.

The roughing wheels are placed on one side of the machine to carry the dust away from the operating parts, and on the opposite side the finishing wheels are placed. Each wheel is provided with an adjustable dust hood. The trucks on which the castings ride, travel automatically from one side of the machine to the other. They are made of malleable iron and are supported on four wheels. The machine can be operated by unskilled labor, and is made in 4, 8, 12 and 16-wheel capacities.

Trade Publications

AIR COMPRESSORS.—The Ingersoll-Rand Co., 11 Broadway, New York City, in a 24-page bulletin, illustrates and describes its Duplex Corliss steam-driven air compressors. Sectional views are given, which clearly show the construction of this machine.

FRICTION CLUTCHES.—The Hill Clutch Co., Cleveland, in a catalog recently issued, illustrates and describes clutches, collar oiling bearings, clutch operators, cut-off couplings, pulleys, gears, shafting, etc. The clutch is described in detail, showing its construction and the method of operation.

FANS.—The American Blower Co., Detroit, in a 16-page Bulletin, recently issued, describes the "Sirocco" type of fans and blowers. The features of their construction are dealt with exhaustively and an installation of the "Sirocco" electric fan and air purifier is illustrated and briefly described.

GAS ENGINES.—The Turner-Fricke Mfg. Co., Sharon, Pa., has issued a 26-page catalog describing its line of gas and gasoline engines. These engines are built in sizes ranging from 25 to 325 horsepower, and the booklet also contains a detailed description of the special features of this power generator.

BATTERY CHARGING RHEOSTATS.—The Cutler-Hammer Mfg. Co., Milwaukee, in a 48-page booklet, illustrates and describes its line of battery charging rheostats, comprising two types for charging ignition batteries and six types for general charging work, for electric pleasure vehicles and trucks.

CRUCIBLES.—The Bridgeport Crucible Co., Bridgeport, Conn., has issued a price list of crucibles and other graphite products which contains pertinent suggestions as to the treatment of crucibles in the brass foundry. This concern manufactures a complete line of crucibles and covers, stirrers, skimmers, phosphor charges, furnace clay, etc.

FIRE BRICK AND REFRACTORY MATERIAL.—In catalog No. 2, issued by the Detroit Foundry Supply Co., Detroit, its line of fire brick and refractory material for foundry use is illustrated and described. Numerous valuable tables are included which will aid the foundryman in lining his cupola, and

tables of temperatures, weights, etc., are also given.

SMOOTH-ON INSTRUCTION BOOK.—The Smooth-On Mfg. Co., Jersey City, N. J., has issued the ninth edition of its instruction book, which is replete with information regarding the use of Smooth-On products. This book contains 96 pages, is well illustrated, and many views are shown of the application of iron cements, sheet packings, etc., made by this concern.

ROTARY BLOWERS.—Catalog No. 32, recently issued by the P. H. & F. M. Roots Co., Connersville, Ind., is devoted to rotary blowers, gas exhausters and pumps manufactured by this concern. Many illustrations are included, among them being a cross-section of a standard blower, showing the impellers. Capacity tables are also given, indicating the size of blowers required for cupolas of various capacities per hour.

FOUNDRY BRUSHES.—The Colonial Brush & Mfg. Co., Milwaukee, in catalog No. 15, containing 140 pages, describes its extensive line of brushes for foundries and plating plants. A varied line of wire brushes is shown for cleaning castings as well as steel wire wheel brushes. Circular scratch brushes and glue brushes are also shown. This concern also manufactures an extensive line of shop brooms and molder's bellows.

MOTORS.—The Sprague Electric Co., New York, in Bulletin No. 600, illustrates and describes its single and polyphase induction motors as well as controllers, starting boxes and rheostats. Several sizes of polyphase induction motors are illustrated, with detailed descriptions of the various parts. The single phase motors, are similar in construction to those of polyphase design and are recommended for service requiring constant speed motors.

OIL BURNING EQUIPMENT FOR OPEN-HEARTH FURNACES.—In an eight-page circular, recently issued by Tate, Jones & Co., Inc., Pittsburg, fuel oil burning equipment for open-hearth furnaces, is illustrated and described. Many views are included showing the application of these burners to open-hearth furnaces in steel foundries in various districts throughout the United States. The use of these burners for drying and heating ladles is also illustrated and described.

TRAVELING ELECTRIC HOISTS.—The Pawling & Harnischfeger Co., Milwaukee, in a 32-page booklet recently issued, illustrates and describes its extensive line of traveling electric hoists. Numerous applications of these hoists are shown. They are built to be operated either from the cage or floor, are adapted for a wide range of service and can be used for handling raw materials in foundry storage yards, for handling metal, for stocking material in warehouses, loading and unloading cars, etc.

PNEUMATIC TOOLS AND AIR COMPRESSORS.—The Sullivan Machinery Co., Chicago, has issued a 112-page catalog entitled "Modern Practice in Air Compression," which contains descriptions and illustrations of the extensive line of pneumatic tools and air compressors made by this concern. The pneumatic tools include rock drills, channeling machines, diamond core drills, coal cutting machines, pneumatic hammer drills, etc. Numerous views of the application of these tools are included, as well as notable installations of air compressors made by this firm.

BLOWING EQUIPMENT.—The American Blower Co., Detroit, in catalog 286, illustrates and describes its extensive line of cupola and forge blowers, ventilating and exhaust fans, heating apparatus, and vertical enclosed, self-oiling steam engines. Several types of blowers are listed, some of which are direct-connected to electric motors, others belt-driven, designed to produce pressure up to 20 ounces per square inch at moderate speeds. This concern also makes heating and ventilating outfits for foundries, and devotes considerable space in the catalog to a description of such apparatus and the methods of application.

PNEUMATIC SAND RAMMERS.—The Ingersoll-Rand Co., 11 Broadway, New York, in Bulletin Nos. 8108 and 8003, describe "Crown" floor and bench rammers, and "Imperial" pneumatic hammers made by this concern. The mechanism of the rammers is described in detail, with sectional illustrations, the various parts being lettered to correspond with a table for convenience in the replacement of worn out parts. Comparative figures are also given of the time consumed in ramming molds of definite size with air rammers and by hand. The bulletin devoted to pneumatic hammers illustrates the different types, and explains the kind of work for which each is adapted.

GRAPHITE PRODUCTS. — The United States Graphite Co., Saginaw, Mich., has issued two handsome catalogs entitled "Graphite Mining in Mexico," and "United States Graphite Co.'s Graphite Products," respectively. The former describes the mining of graphite in Mexico and is handsomely illustrated, not only showing the mines, methods of mining and transporting graphite, but also contains many views of scenes in Mexico. The catalog describing the company"s graphite products contains 38 pages. The product is especially adapted for use as a foundry facing and a special grade is manufactured for brass founders. Graphite paints, lubricants, etc., are also described.

MOLDING MACHINES.—Henry E. Pridmore, Chicago, has issued a handsomely illustrated catalog containing 54 pages, which is termed an "Automobile Edition," in view of the fact that it contains many views of the use of Pridmore molding machines in the production of molds for automobile castings. The molding of cylinders on rock-over drop machines is outlined, and a floor of these molds in a large Detroit foundry is shown. The method of fitting up these cylinder patterns is also described, as well as the method of mounting fly wheels and other automobile patterns on rock-over machines. The catalog shows an unusual variety of automobile work, with many illustrations of machines in actual use. Brief reference is also made to the different types of machines built by this firm. A list of foundries making a specialty of castings for motor cars, and in which Pridmore machines are used, is also included.

POSITIVE BLOWERS.—The Piqua Blower Co., Piqua, O., in a 48-page catalog, recently issued, illustrates and describes its extensive line of positive and high pressure blowers, rotary compressors, exhausters, gas boosters, rotary pumps, flexible couplings and vacuum regulators. A detailed description is given of the Piqua blowers, with several sectional views, which clearly illustrate the principles of operation. Various types of blowers are described, adapted for the production of high or low blast pressures, to suit varying requirements. Some of the advantages of this type of blower are a large air inlet, allowing air at atmospheric pressure to enter freely and practically fill the cylinder, which eliminates air friction and consequent rarefaction of air in the same. As a comparatively large proportion of the output is in motor-driven units, several such combinations are shown, adapted to either alternating or direct currents, and other blowers are illustrated connected to steam engines of both the vertical and horizontal types.

FOUNDRY EQUIPMENT. — The Calumet Engineering Works, Harvey, Ill., in a handsomely illustrated catalog containing 62 pages, describes its extensive line of foundry equipment, as well as cranes for general industrial service. The scope of this company's plant is shown by a birdseye view of the works as well as by interior illustrations of the pattern, machine, erecting and structural fitting shops, and the foundry. Sectional views of the Calumet cupola are included, which graphically show the construction of this furnace and capacity tables are given for cupolas of various sizes. The extensive line of ladles made by this concern is also shown, as well as cast iron stave tumbling mills, steel plate tumblers, etc. Turntables, as well as cars for industrial systems are illustrated and special types of annealing cars and charging cars are shown. In addition, belt-power and pneumatic elevators, core ovens, core oven trucks, brass melting furnaces, air hoists and an extensive line of traveling cranes are included, with views of numerous installations in shops and railroad yards throughout the country.

TILTING CRUCIBLE FURNACES.—The Rockwell Furnace Co., 26 Cortlandt street, New York City, in Bulletin 7, describes and illustrates its new tilting crucible melting furnace, adapted for oil or gas as fuel. This furnace is used for melting aluminum, brass, copper, cobalt, gold, iron, manganese, silver, vanadium, etc., and possesses many advantages which will be appreciated by brass foundrymen. The burner, which is operated with an air blast of 12 ounces, makes little noise, and the furnace is constructed with a combustion chamber in the rear, the flame being projected downward against the bottom of the chamber, and not against the crucible, which greatly assists in prolonging its life. Should the crucible break the metal is held in the furnace and the heat continued and poured as if no crucible were used. This enables the operator to get several heats from a crucible after it would otherwise have been abandoned for fear of breaking. In the No. 11 furnace, 350 pounds of gates and miscellaneous scrap have been melted in 30 minutes, using a crucible, while without a crucible, 650 pounds were melted in less than an hour and a half. The quantity of fuel required and the time of melting vary according to the degree of heat required, the amount and quality of the metal melted and the promptness with which it is handled and poured. These furnaces are made in four sizes and with the average foundry mixtures, nine heats a day can be melted in a No. 10 furnace, eight in a No. 11, seven in a No. 12, and six in a No. 13.

The National Cash Register Co., Dayton, O., is increasing the capacity of its brass foundry by the installation of 30 pit furnaces, which will enable it to increase the output from 26,000 pounds to 30,000 pounds daily, and will necessitate the employment of 25 additional molders. Experiments will also be made with oil-fired crucible furnaces, comparing their efficiency with each other, and the coke furnaces. A tilting furnace of 800 pounds capacity will be installed for melting scrap, such as borings, skimmings, washings, etc., which will be cast into ingots, and for making castings for the small inside parts of the cash registers. In addition to these improvements, a new concentrating plant will be installed, at an estimated cost of $5,000, for the salvage metal from the ashes, skimmings, etc. This will take the place of the present plant.

GENERAL INDUSTRIAL NOTES

The Pontiac Foundry Co., Pontiac, Mich., has been incorporated for $80,000.

The James Foundry Co., Clyde, O., has been incorporated for $50,000 by C. D. James, Winfield Adare, H. M. Bacon, J. W. Flickinger and E. W. Baker.

The McKenzie Furnace Co., Chicago, with offices at 84 Van Buren street is completing a foundry and finishing shop, 75 x 300 feet, at Chicago Ridge, Ill.

The Keystone Steel Castings Co., Chester, Pa., has practically completed additions to its plant, which will increase the facilities of its crucible steel melting department enabling the company to triple its former output of steel castings.

The Walker & Pratt Mfg. Co., Boston, has recently extended its foundry, and the molding floor now covers an area 120 x 400 feet. The subsidiary departments have also been increased by the erection of a building, 100 x 35 feet.

The Smith-Mathews Foundry Co., Detroit, has completed its new plant at Bellevue and Charlevoix street. Robert Smith is president of the company; Harry H. Smith, vice president and D. H. Mathews, secretary and treasurer.

The Prime Steel Co., Milwaukee, has extended and improved its Dutcher works on Kinnickinnic avenue by the addition of a drafting room, laboratory, pattern shop, core rooms and a foundry extension which includes a 20-ton open-hearth furnace.

The Fairview Foundry Co. has been incorporated as a subsidiary of the Chalmers Motor Co., Detroit, and will make all castings used in the manufacture of Chalmers motor cars. The plant is being equipped with the most modern machinery for casting gray iron, brass and aluminum, and consists of two buildings, one for aluminum and one for gray iron and brass castings.

New Construction.

The Pontiac Foundry Co., Pontiac, Mich., will erect a foundry, 70 x 300 feet.

Chas. Leonhardt, New Ulm, Minn., is considering the erection of a foundry and machine shop.

The Kilbourn Specialties Co., Kilbourn, Wis., is having plans prepared for the erection of a foundry.

The Baggert Foundry Co., Racine, Wis., will erect a foundry, 60 x 60 feet, of brick and steel frame construction.

Jackson & George, Saginaw, Mich., have purchased a site and have had plans prepared for a new foundry, boiler shop, machine shop, etc.

The Deane Steam Pump Co., Holyoke, Mass., a branch of the International Steam Pump Co., will build a new foundry, 290 x 150 feet.

The International Harvester Co. of Canada, Ltd., Hamilton, Ont., is constructing an addition to its gray iron foundry, 140 x 150 feet, two stories high.

The Elkins Foundry & Machine Co., Elkins, W. Va., contemplates the erection of a gray iron foundry which will have a capacity of about three tons daily.

The Lima Locomotive & Machine Works, Lima, O., contemplate an enlargement of their plant at a cost of $200,000. The new buildings will include a large foundry.

The International Harvester Co., Milwaukee, has completed plans and selected a site for the new foundry to be erected adjacent to its works. The construction will be brick and steel, with a saw-tooth roof.

The Wason Manufacturing Co., Springfield, Mass., has bought a large tract of land in Brightwood adjoining its property on which it will extend its plant, by the addition of a foundry, 50 x 100 feet, one story high.

The Caldwell & Watson Foundry Co., Bessemer, Ala., will construct a foundry at a cost of $25,000. The present building at Fifth avenue and Thirteenth street will be torn down and a new structure erected on the present site.

The City Foundry Co., Warren, O., has secured the building formerly owned by the DeWaldo-Taylor Co., and will raise the west portion of the building to two stories, installing a full equipment of machinery necessary for the operation of a jobbing foundry.

The Sterling Foundry Co., Sterling, Ill., is erecting a foundry that will double the capacity of its present plant, and a two-story building, 40 x 85 feet for erecting, finishing and shipping its product. It is expected that the building will be completed by September 1.

The Crane Co., Chicago, Ill., is erecting a four-story building, 110 x 120 feet, for the first section of its brass department. The building will be of concrete fireproof construction, in accordance with the company's policy of installing all its manufacturing business in fireproof buildings.

The three plants of M. H. Treadwell & Co. at Myerstown and Lebanon, Pa., will be consolidated under one management at Easton, Pa. The buildings for the new plant will be of steel and fireproof construction, and will cost approximately $300,000, exclusive of equipment.

The J. W. Pohlman Foundry Co., Buffalo, has purchased the plant of the Buffalo Steel & Shafting Co. and will take possession as soon as contemplated improvements are completed. The company will build a warehouse and office building, 32 x 130 feet. The foundry building already erected is 62 x 240 feet. The company manufactures stoves and ranges.

The Charter Oak Stove & Range Co., St. Louis, is erecting a new plant on a 16-acre site, near the East line of the St. Louis Water Works conduit. Four buildings will be erected, comprising 270,000 square feet. The main building will be 576 x 313 feet, one story, and will contain the foundry, pattern storage, mounting shops, as well as a warehouse, shipping, boiler and engine rooms. The other detached buildings include an office, 100 x 100 feet and the pattern shop, 100 x 100 feet.

The New York Air Brake Co., New York City, is erecting the first unit of its new machine shop on a site adjoining its iron and brass foundry, known as the "East Plant," at Watertown, N. Y. The machine shop will be 360 x 200 feet, of fireproof construction throughout. Contract for the steel frame work was awarded the Berlin Bridge Co. David Lupton's Sons have been awarded the contract for the Pond continuous sash for the saw tooth bays and the concrete piers and parapet walls will be built by Charlebois Bros., Watertown, N. Y.

Among the Brass Foundries.

The Youngstown Bronze & Iron Foundry Co., Youngstown, is erecting an addition to its brass foundry.

The Burlington Bronze Co., Burlington, Wis., has increased its capital stock from $70,000 to $200,000.

The Scovill Manufacturing Co., Waterbury, Conn., has taken out a permit to erect an addition to its foundry, 55 x 60 feet, one story high.

The Buick Motor Co., Flint, Mich., has commenced the erection of another plant, which will be devoted to the manufacture of brass and aluminum castings.

The Erie Brass Foundry, Meadville, Pa., has been acquired by the Bronze Metal Co., New York, successors to the Metal Corporation, manufacturers of metal for bearings.

The Apex Manufacturing Co., Louisville, has been recently incorporated and taken over the brass foundry of John H. Cowles & Co. No new equipment will be added at present.

The Aluminum Castings Co., Cleveland, manufacturer of aluminum, brass and bronze castings, is making additions to its plant at Fairfield, Conn., which will double its capacity.

Lewis Bros. Brass & Machine Works, Seattle, Wash., will be reincorporated under the name of Western Brass Works, with a capital of $5,000. It is proposed to build a factory and foundry on a site already obtained.

The Gray Foundry Co., Reading, Pa., will erect a building three stories high, 25 x 40 feet, at an estimated cost of $2,000. This concern has, in addition to a brass foundry, a metal working shop and a plating room.

The Detroit Aluminum Solder Co., 61 Fort street, Detroit, has been incorporated for $2,000 to engage in the manufacture of aluminum solder. The officers are Herman B. Strate, president; J. M. Trudell, vice-president; J. J. Jerome, secretary and treasurer.

The Standard Metal Mfg. Co., Chicago, has made arrangements for the erection of a foundry in North Fond du Lac, Wis., providing the village donates the site. The company recently entered into a contract with the Soo line to furnish it with all of its brass castings.

The Bronze Metal Co., New York City, is now operating the brass foundries of the Erie Railroad, Meadville, Pa. New equipment has been installed, including a Berkshire automatic molding machine, core ovens, etc. purchased from W. H. Nicholls, 30 Church street, New York City.

The Crown Cork & Seal Co., Baltimore, has begun operations in its new brass and aluminum foundry. The foundry building is 40 x 70 feet, has an extremely high ceiling and is well ventilated and lighted. The furnace include two tilting coke furnaces of 600 pounds capacity and three crucible fires of the usual type.

The Bunting Brass & Bronze Co., Alliance, O., has plans completed for the erection of a foundry, 54 x 250 feet, machine shop, 54 x 100 feet, together with several buildings of lesser size for warehouses, pattern vaults, etc. The shops will be equipped to handle both light and heavy castings and for the finishing of small duplicate parts. The location has not been definitely decided upon, but it is probable that it will be west of Alliance, O.

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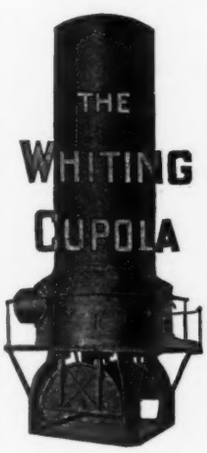

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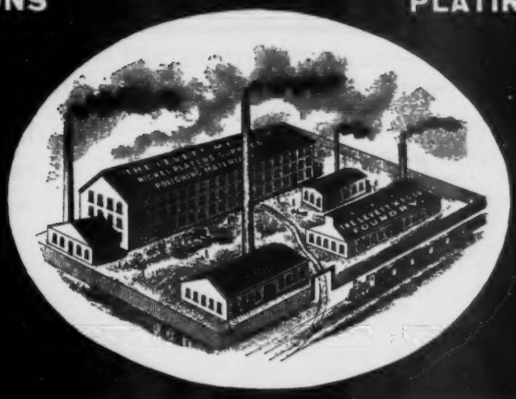

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American Vanadium Co., Pittsburg, Pa.

ALUMINUM.

Vernon Metal Co., New York City.

ANALYSIS.

(Mechanical.)

Keep, W. J., Detroit, Mich.

ANCHORS.

Lindsay, W. W., & Co., Philadelphia.

ANNEALING OVENS.

Whiting Fdy. Equipment Co., Harvey, Ill.

ANODES.

(Nickel.)

Levett Mfg. Co., Matawan, N. J.

BABBITT METAL.

Ajax Metal Co., Birmingham, Ala.
Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

BARRELS.

(Factory.)

Cleveland Wire Spring Co., Cleveland, O.

BELLOWS.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Clark, Thos. A., Cleveland, O.
Dobson, Wm., Canastota, N. Y.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

BLACKING MIXTURES.

Smith, J. D., Fdy. Supply Co., Cleveland, O.

BLOWERS.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Piqua Blower Co., Piqua, O.
Roots, P. H. & F. M., Co., Connersville, Ind.
Sirocco Engineering Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

BLOWERS.

(Positive Pressure.)

Connersville Blower Co., Connersville, Ind.
Pangborn Company, Thomas W., New York.
Piqua Blower Co., Piqua, O.
Roots, P. H. & F. M., Co., Connersville, Ind.
Sturtevant, B. F., Co., Hyde Park, Mass.

BOXES.

(Annealing)

Whiting Fdy. Equipment Co., Harvey, Ill.

BOXES.

(Factory.)

Cleveland Wire Spring Co., Cleveland, O.

BRAZING OUTFITS.

Rockwell Furnace Co., New York.

BRONZE.

(Manganese.)

Ajax Metal Co., Philadelphia, Pa.
Damascus Bronze Co., Pittsburg, Pa.

BRONZE.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

BRUSHES.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Federal Fdry. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Levett Mfg. Co., Matawan, N. J.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

BUFFS.

Levett Mfg. Co., Matawan, N. J.

BURNERS.

(Oil.)

Anthony Co., New York, N. Y.
Pangborn Company, Thomas W., New York.
Rockwell, W. S., New York.
Rockwell Furnace Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.
Levett Mfg. Co., Matawan, N. J.

CARS.

(Annealing, Pig Iron, Etc.)

Atlas Car & Mfg. Co., Cleveland, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Charging.)

Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Core Oven.)

Atlas Car & Mfg. Co., Cleveland, O.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Whiting Fdy. Equipment Co., Harvey, Ill.

CARS.

(Industrial.)

Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

CASTINGS.

(Phosphor-Bronze.)

Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

CASTINGS.

(Steel.)

Otis Steel Co., Ltd., Cleveland.

CASTINGS.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

CEMENT.

(Furnace.)

Gautier, J. H., & Co., Jersey City.

CEMENT.

(Iron.)

Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.

CEMENT.

(Metallic.)

Clark Cast Steel Cement Co., Shelton, Conn.
Johns-Manville, H. W., Co., New York, N. Y.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CEMENT.

(Steel)

Shanafelt Mfg. Co., Canton, O.

CHAPLETS.

Burdick & Son, Albany, N. Y.
Champion Machine & Forging Co., Cleveland, O.
Federal Foundry Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Lindsay, W. W., & Co., Philadelphia.
Philadelphia Chaplet & Mfg. Co., Philadelphia.
Rochester Fdy. Co., Rochester, N. Y. (Gray iron.)
Shanafelt Mfg. Co., Canton, O.

CHAPLETS.

(Perforated.)

Obermayer, S., Co., Cincinnati, O.

CHEMISTS.

Bayless Chemical Laboratory, Muncie, Ind.
Cox, W. W., Kansas City, Mo.
Davis, Geo. C., Philadelphia, Pa.
Engineers & Founders Laboratories, Pittsburg.
Gulick-Henderson & Co., Pittsburg, Pa.
Metallurgical Laboratory, Pittsburg, Pa.
Smith, Rudy & Co., Philadelphia, Pa.

CHIPPERS.

Ingersoll-Rand Co., New York, N. Y.
Pittsburg Pneumatic Tool Co., Canton, O.

CINDER MILLS.

Cleveland Nickel Works, Cleveland, O.

CLAMPS.

(Flask.)

Barnett, Oscar, Fdy. Co., Newark, N. J.
Josef, E. E., Mfg. Co., Buffalo, N. Y.

COKE.

Baird & West, Detroit, Mich.
Debevoise-Anderson Co., New York.
Hanna & Co., M. A., Cleveland, O.
Hillman, J. H., & Son, Pittsburg.
Matlack & Bates, Philadelphia, Pa.
Mount Carbon Co., Ltd., Powellton, W. Va.
Pilling & Crane, Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.
Samuel, Frank, Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.

COKE.

(Crushed.)

Mount Carbon Co., Ltd., Powellton, W. Va.

COMPOSITIONS.

Levett Mfg. Co., Matawan, N. J.

CONVERTERS.

(Side Blown Steel.)

Stoughton Engineering Co., New York City.
Tropenas Steel Co., Newcastle, Del.
Whiting Fdy. Equipment Co., Harvey, Ill.

COPPER.

Vernon Metal Co., New York City.

COPPER.

(Phosphorized.)

Damascus Bronze Co., Pittsburg, Pa.

CORE BINDERS.

Federal Fdy. Supply Co., Cleveland, O.
Independence Mfg. Co., Philadelphia, Pa.
Obermayer, S., Co., Cincinnati, O.
Robeson Process Co., Au Sable Forks, N. Y.

CORE COMPOUND.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Holland Linseed Oil Co., Chicago, Ill.
Independence Mfg. Co., Philadelphia, Pa.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
National Core Oil Co., Buffalo, N. Y.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

CORE FLOUR.

Paxson Co., J. W., Philadelphia, Pa.
Piqua Flour Co., Piqua, O.

CORE MACHINES.

Brown Specialty Machinery Co., Chicago, Ill.
Falls Rivet & Mach. Co., Cuyahoga Falls, O.
Pangborn Company, Thomas W., New York.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

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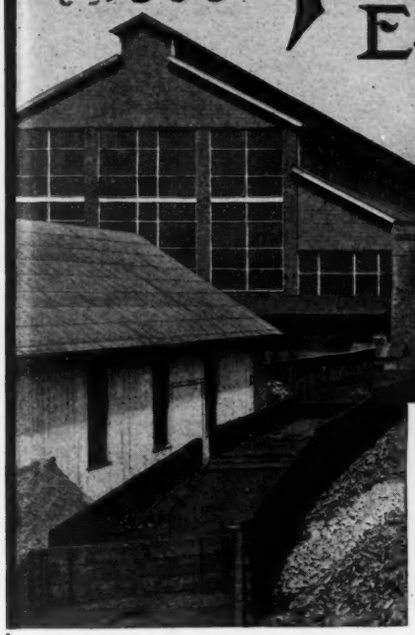

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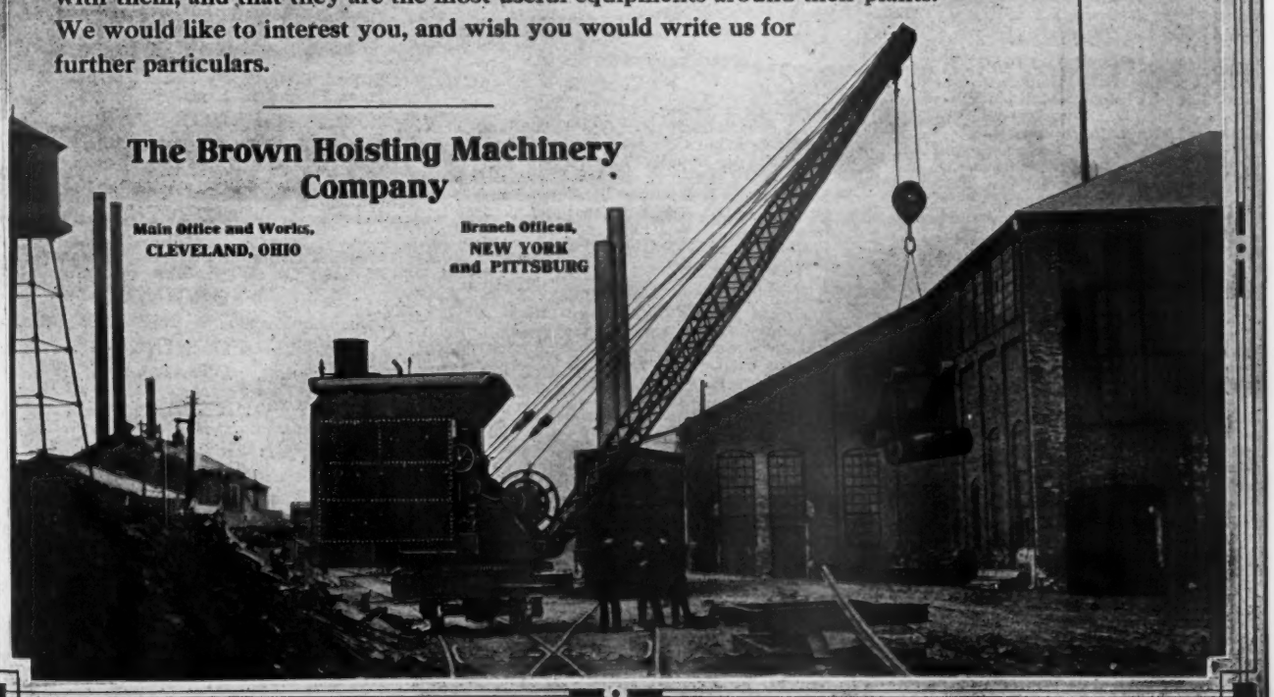

CORE OIL.

Holland Linseed Oil Co., Chicago, Ill.
Independence Mfg. Co., Philadelphia, Pa.
Keystone Foundry Supply Co., Buffalo, N. Y.
National Core Oil Co., Buffalo, N. Y.
Paxson, J. W., Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, and Buffalo.

CORE OIL COMPOUND.

Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.

CORE OVENS.

Falls Rivet & Mach. Co., Cuyahoga Falls, O.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Millett Core Oven Co., Springfield, Mass.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Co., W. S., New York City.
Smith, J. D., Foundry Supply Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

CORE.

(Tapering Machines.)

Brown Specialty-Machinery Co., Chicago, Ill.
Pangborn Company, Thomas W., New York.

CORE RACKS.

Terrell's Equipment Co., Grand Rapids, Mich.

CORE WASH.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Federal Fdy. Supply Co., Cleveland, O.

CORRESPONDENCE SCHOOLS.

Milwaukee Correspondence Schools, Milwaukee.

COUPLINGS.

(Air Hose.)

Cleveland Pneumatic Tool Co., Cleveland, O.

CRANES.

Brown Hoisting Machine Co., Cleveland, O.
Calumet Engineering Works, Harvey, Ill.
Case Crane Co., Columbus, O.
Cleveland Crane & Engrg. Co., Wickliffe, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Maris Bros., Philadelphia, Pa.
Morgan Engineering Co., Alliance, O.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Quincy, Manchester, Sargent Co.,
Plainfield, N. J.
Ridgway, Craig & Son, Coatesville, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co.,
Montour Falls, N. Y.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Toledo-Massillon Bridge Co., Toledo, O.
Whiting Fdy. & Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

CRANES.

(Hand Traveling.)

Calumet Engineering Works, Harvey, Ill.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Toledo-Massillon Bridge Co., Toledo, O.
Whiting Fdy. Equipment Co., Harvey, Ill.

CRUCIBLES.

Barnett, Oscar, Fdy. Co., Newark, N. J.
Bartley Crucible Co., Jonathan, Trenton, N. J.
Buffalo Foundry Supply Co., Buffalo, N. Y.
Dixon Crucible Co., Inc., Jersey City.
Gautier, J. H., & Co., Jersey City.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Keystone Foundry Supply Co., Buffalo, N. Y.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paige Retort & Crucible Co., Taunton, Mass.
Paxson Co., J. W., Philadelphia, Pa.
Ross-Tacony Crucible Co., Philadelphia, Pa.
Seidel, R. B., Inc., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.

CRUCIBLE FURNACES.

Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Furnace Co., New York.

CUPOLAS.

Barry & Zecher Co., Lancaster, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Calumet Engineering Works, Harvey, Ill.
McCormick, J. S., Co., Pittsburg, Pa.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Whiting Fdy. & Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

CUPRO-VANADIUM.

American Vanadium Co., Pittsburg, Pa.

CYLINDERS.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

DOWEL PINS.

Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.

DRILLS.

(Pneumatic.)

Ingersoll-Rand Co., New York, N. Y.

DROSS SAVERS.

Metal Dross Economy Co., Bristol, Conn.

DUST COLLECTORS.

Knickerbocker Co., Jackson, Mich.

DYNAMOS.

(Plating.)

Levett Mfg. Co., Matawan, N. J.

ELECTRIC GENERATING SETS.

Sturtevant, B. F., Co., Hyde Park, Mass.

ELEVATORS.

Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Works, Detroit, Mich.
Ridgway, Craig, & Son, Coatesville, Pa.

ELEVATORS.

(Electric.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

ELEVATORS.

(Pneumatic.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

EMERY GRINDERS.

Osborn Mfg. Co., Cleveland, O.
Smith, J. D., Fdy. Supply Co., Cleveland, O.

ENGINES.

(Hoist, Automatic.)

Otis Elevator Co., New York City.

ENGINES.

(Steam.)

American Blower Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

ENGINEERS.

(Foundry, Mech., Elec., Etc.)

Gulick-Henderson & Co., Pittsburg, Pa.
Hawkins, David S., 1021 Rose bldg, Cleveland.
Lindsay, W. W., & Co., Philadelphia.
Northern Engineering Works, Detroit, Mich.
Pangborn Company, Thomas W., New York.
Seaver, John W., Cleveland, O.
Smith Foundry Supply Co., J. D., Cleveland, O.
Wonham, Sanger & Bates, New York City.

EQUIPMENT.

(Hoisting.)

Otis Elevator Co., New York City.

EXHAUST FANS.

Sturtevant, B. F., Co., Hyde Park, Mass.

EXHAUSTERS.

(Gas.)

Buffalo Forge Co., Buffalo, N. Y.

FACINGS.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Combined Foundry Supply Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City.
Federal Fdy. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
McCormick, J. S., Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.
Stevens, Frederic B., Detroit, Mich.

FANS.

American Blower Co., Detroit, Mich.
Anthony Co., New York, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Sirocco Engineering Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

FASTENERS.

(Corrugated Steel.)

Shanafelt Mfg. Co., Canton, O.

FERRO-ALLOYS.

American Vanadium Co., Pittsburg, Pa.
Blackwell, G., Sons & Co., Ltd., Liverpool, Eng.
Primos Chemical Co., Primos, Pa.

FERRO-COMPOUND.

Johns-Manville, H. W., Co., New York, N. Y.

FERRO-MANGANESE.

Metal Mfg. Co., Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.
Stevens, Frederic B., Detroit, Mich.

FERRO-SILICON.

Metal Mfg. Co., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.
Roessler & Hasslacher Chemical Co., New York.

FERRO-VANADIUM.

American Vanadium Co., Pittsburg, Pa.
Primos Chemical Co., Primos, Pa.

FILLERS.

(Metallic.)

Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City, N. J.

FILLETS.

(Leather and Wood.)

Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Shanafelt Mfg. Co., Canton, O.
Simplicity Mfg. Co., Cleveland, O.

FIRE BRICK.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Combined Fdy. Supply Co., Buffalo, N. Y.
Gautier, J. H., & Co., Jersey City.
Harbison-Walker Refractories Co., Pittsburg, Pa.
Maurer, Henry, & Son, New York City.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Valentine, M. D., & Bro., Co., Woodbridge, N. J.
Wonham, Sanger & Bates, New York City.

FIRE CLAY.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Gautier & Co., J. H., Jersey City, N. J.
Paxson Co., J. W., Philadephia, Pa.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

FIRE SAND.

Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

FLASKS.

Adams Co., Dubuque, Iowa.
Baldwin, Tuthill & Bolton, Grand Rapids, Mich.
Barnett, Oscar, Fdy. Co., Newark, N. J.
Brass Founders' Supply Co., Newark, N. J.
Killing Molding Machine Co., Davenport, Ia.
Shanafelt Mfg. Co., Canton, O.
Smith & Caffrey Co., Syracuse, N. Y.
Sterling Wheelbarrow Co., Milwaukee, Wis.
Stevens, Frederic B., Detroit, Mich.

FLASKS.

(Iron.)

Turner Machine Co., Philadelphia, Pa.

FLASKS.

(Snap.)

Adams Co., Dubuque, Iowa.
Brass Founders' Supply Co., Newark, N. J.
Buffalo Foundry Supply Co., Buffalo, N. Y.
Killing Molding Machine Co., Davenport, Ia.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Smith & Caffrey Co., Syracuse, N. Y.
Smith, J. D., Fdy. Supply Co., Cleveland, O.

FLOUR.

(Core.)

Federal Fdy. Supply Co., Cleveland, O.
Piqua Flour Co., Piqua, O.

FLUOR-SPAR.

Stevens, Frederic B., Detroit, Mich.

FLUX.

International Flux Co., Evansville, Ind.

FORGES.

(Oil.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Co., W. S., New York City.

FORGINGS.

Champion Machine & Forging Co., Cleveland.

FORGINGS.

(Vanadium.)

American Vanadium Co., Pittsburg, Pa.

FOUNDRY COKE.

Mount Carbon Co., Ltd., Powellton, W. Va.

FOUNDRY EQUIPMENT.

(Iron and Brass.)

Barnett, Oscar, Foundry Co., Newark, N. J.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Nicholls, Wm. H., New York City.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.
Sly, W. W., Mfg. Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

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The Cincinnati Iron & Steel Co., Cincinnati, Ohio

FOUNDRY SUPPLIES.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Combined Foundry Supply Co., Buffalo, N. Y.
Federal Fdy. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Keystone Foundry Supply Co., Buffalo, N. Y.
McCormick, J. S., Co., Pittsburg, Pa.
Metal Mfg. Co., Philadelphia, Pa.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

FUEL BURNING APPLIANCES.

(Oil.)

Hauck Mfg. Co., Brooklyn, N. Y.

FURNACES.

Anthony Co., New York, N. Y.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Annealing.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Furnace Co., New York.

FURNACES.

(Brass.)

Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Paxson Co., J. W., Philadelphia, Pa.
Rockwell Furnace Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wise, J. B., Watertown, N. Y.
Wonham, Sanger & Bates, New York City.

FURNACES.

(Case Hardening.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Crucible Steel.)

Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Galvanizing.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

FURNACES.

(Heating.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Furnace Co., New York.

FURNACES.

(Malleable Iron.)

Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Melting.)

Barnett, Oscar, Foundry Co., Newark, N. J.
Brass Founders' Supply Co., Newark, N. J.
Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia.
Rockwell Furnace Co., New York.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Oil.)

Hauck Mfg. Co., Brooklyn, N. Y.
Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Furnace Co., New York.

FURNACES.

(Open Hearth Steel.)

Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES.

(Reverberatory.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Rockwell Co., W. S., New York City.

FURNACES.

(Soft Metal Melting.)

Kroeschell Bros. Co., Chicago, Ill.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Tilting.)

Kroeschell Bros. Co., Chicago, Ill.
Wise, J. B., Watertown, N. Y.

FURNACES.

(Tinning.)

Monarch Engrg. & Mfg. Co., Baltimore, Md.

GENERATORS.

(Acetylene.)

Goodyear, Nelson, Inc., New York, N. Y.

GRAPHITE.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Federal Fdry. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.

GRINDERS.

(Pneumatic, Portable.)

Cleveland Pneumatic Tool Co., Cleveland, O.

GRINDING MACHINERY.

Adams Co., Dubuque, Iowa.
Crescent Machine Co., Leetonia, O.

GRINDING TOOLS.

Stow Mfg. Co., Binghamton, N. Y.

HAMMERS.

(Pneumatic.)

Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.

HEATING AND VENTILATING APPARATUS.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sirocco Engineering Co., Detroit, Mich.
Sturtevant, B. F., Co., Hyde Park, Mass.

HOISTS.

Brown Hoisting Mach. Co., Cleveland, O.
Case Crane Co., Columbus, O.
Detroit Hoist & Machine Co., Detroit, Mich.
Northern Engineering Works, Detroit, Mich.
Ridgway & Sons Co., Coatesville, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co.,
Montour Falls, N. Y.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Air.)

Calumet Engineering Works, Harvey, Ill.
Ingersoll-Rand Co., New York, N. Y.

HOISTS.

(Chain.)

Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

HOISTS.

(Electric.)

Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Quincy, Manchester, Sargent Co.,
Plainfield, N. J.
Sprague Electric Co., New York City.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

HOISTS.

(Hand.)

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

HOISTS.

(Pneumatic.)

Curtis & Co. Mfg. Co., St. Louis, Mo.
Detroit Hoist & Machine Co., Detroit, Mich.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

HOISTS.

(Skip.)

Otis Elevator Co., New York City.

HOSE.

(Pneumatic.)

Cleveland Pneumatic Tool Co., Cleveland, O.

INDUSTRIAL RY. EQUIPMENT.

Atlas Car & Mfg. Co., Cleveland, O.
Johns-Manville, H. W., Co., New York, N. Y.
Northern Engineering Works, Detroit, Mich.

IRON ORE.

Rogers, Brown & Co., Cincinnati, O.

KAOLIN.

Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

LADLES.

Calumet Engineering Works, Harvey, Ill.
Northern Engineering Works, Detroit, Mich.
Paxson Co., J. W., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Sanger & Bates, New York City.

LADLE DRYERS.

Pangborn Company, Thomas W., New York.

LADLE HEATERS.

Monarch Engrg. & Mfg. Co., Baltimore, Md.
Pangborn Company, Thomas W., New York.
Rockwell Furnace Co., New York.

LEAD.

Federal Fdy. Supply Co., Cleveland, O.

LEAD.

(Black.)

Federal Fdy. Supply Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.

LOCKERS.

(Metal.)

Terrell's Equipment Co., Grand Rapids, Mich.

MACHINERY.

(Wood Working.)

Baldwin, Tuthill & Bolton, Grand Rapids, Mich.
Crescent Machine Co., Leetonia, O.

MATCH-PLATES.

Goodale Co., Kalamazoo, Mich.

MECHANICAL DRAFT APPARATUS.

American Blower Co., Detroit, Mich.
Sirocco Engineering Co., Detroit, Mich.
Sturtevant, B. F., Co., Tyde Park, Mass.

METALS.

Birkenstein & Sons, S., Chicago, Ill.
Damascus Bronze Co., Pittsburg, Pa.
Vernon Metal Co., New York City.

METALLURGISTS.

Gulick-Henderson & Co., Pittsburg, Pa.
Stoughton Engineering Co., New York City.

MOLD DRYERS.

Hauck Mfg. Co., Brooklyn, N. Y.
Monarch Engrg. & Mfg. Co., Baltimore, Md.
Pangborn Company, Thomas W., New York.

MOLDING MACHINES.

Adams Co., Dubuque, Iowa.
Arcade Mfg. Co., Freeport, Ill.
Ardelt & Sons, Eberswalde, Germany.
Berkshire Mfg. Co., Cleveland, O.
Buch's Sons, Elizabethtown, Pa.
Combined Foundry Supply Co., Buffalo, N. Y.
Herman Pneumatic Mach. Co., Zelienople, Pa.
Killing Molding Machine Co., Davenport, Ia.
Midland Machine Co., Detroit, Mich.
Mumford Molding Machine Co., New York City.
Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.
Pridmore, Henry E., Chicago, Ill.
Rowlands Machine Co., Racine Junction, Wis.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Tabor Mfg. Co., Philadelphia, Pa.
Turner Machine Co., Philadelphia, Pa.

MOTORS.

(Electric.)

Levett Mfg. Co., Matawan, N. J.

NAILS.

(Foundry.)

Rochester Foundry Co., Rochester, N. Y.

PACKING.

(Rubber Sheet.)

Smooth-On Mfg. Co., Jersey City.

PARTING COMPOUNDS.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Federal Fdry. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
McCormick, J. S., Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.
Whitehead Bros. Co.,
Providence, New York, Buffalo.

PATTERN LETTERS.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.
Shanafelt Mfg. Co., Canton, O.

PATTERN LUMBER.

Thompson, Lewis, & Co., Philadelphia, Pa.

PATTERNS.

(Metal and Wood.)

Herman Pneumatic Mach. Co., Zelienople, Pa.

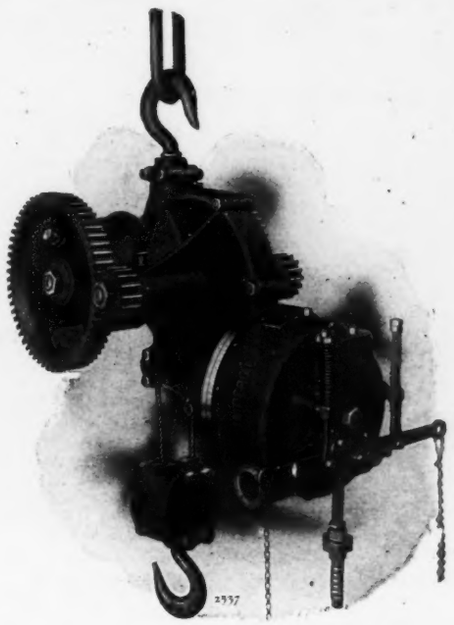
PATTERN SHOP EQUIPMENT.

Standard Pattern Works Co., Cleveland, O.

PHOSPHORIZERS.

Dixon Crucible Co., Jos., Jersey City.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
New Era Mfg. Co., Kalamazoo.

"IMPERIAL" HOISTS CUT DOWN NON-PRODUCTIVE TIME



The time consumed in handling work and materials is non-productive time. The more you reduce it the larger is the percentage of time in which your machines and labor are actually producing.

You can let your men do this work by hand. **Paying productive wages for non-productive work.**

Or, you can install "Imperial" Motor Hoists to do this work, in a fraction of the time required by hand and at merely the slight cost for air consumed.

Your men will thus be kept busy on productive work for a greater part of the time, meaning that **your foundry capacity will be increased without adding to your labor force or floor space.**

This is the plainest business proposition; and an investigation of the possibilities of the "Imperial" Hoist in your foundry will, we feel sure, convince you of its profit-earning capacity.

We will be glad to send you Bulletin 8006.

PNEUMATIC TOOLS AIR COMPRESSORS

PNEUMATIC SAND RAMMERS

Ingersoll-Rand Co.

NEW YORK **LONDON**

DOMESTIC OFFICES:

Birmingham, Boston, Butte, Chicago, Cleveland, Denver, Duluth, El Paso, Knoxville, Philadelphia, Pittsburg, St. Louis, Salt Lake, San Francisco, Seattle

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A Triplex Block used in pouring in a foundry.

Up, Down or Sideways

THERE is no way of so easily and safely handling a ladle full of hot iron as with a Triplex Block on a trolley. An easy pull on the hand chain raises or lowers it—the push of the operator moves it sideways.

And the same inexpensive installation handles sand, cores and castings in the same easy way. It not only makes the direct saving of labor, but it allows for a freer use of floor-space—it means more output from the same space. It requires no wide aisles—no smooth floors—everthing is carried overhead—quickly, silently and with absolute safety.

Any one of our three hundred dealers will send *you* a Triplex Block to try—if you will ask them.

CHAIN BLOCKS

4 Styles: Differential, Duplex, Triplex, Electric.
42 Sizes: One-eighth of a ton to forty tons.
300 Active Stocks: ready for instant call all over the U. S.

Send for the Book of Hoists today—yours for a postcard

The Yale & Towne Mfg. Company

Only Makers of Genuine *Yale Products*

9 Murray Street - - - New York

Local Offices: Chicago, Philadelphia, Boston, San Francisco

PIG IRON.

Addy, Mathew, & Co., Cincinnati, O.
Breen, Wm. J., Co., Boston, Mass.
Goodrich, F. A., & Co., Detroit, Mich.
Hanna & Co., M. A., Cleveland, O.
McKeefrey & Co., Leetonia, O.
Mohr, J. J., Philadelphia, Pa.
Nash, Isham, & Co., New York.
Perry Iron Co., Erie, Pa.
Pickands, Mather & Co., Cleveland, O.
Pilling & Crane, Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.
Samuel, Frank, Philadelphia, Pa.
Superior Charcoal Iron Co., Grand Rapids, Mich.
Thomas Furnace Co., Milwaukee, Wis.
Walter-Wallingford & Co., Cincinnati and Pittsburg.

PIPE COVERING.

Johns-Manville, H. W., Co., New York, N. Y.

PLUMBAGO.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City.
Federal Fdry. Supply Co., Cleveland, O.
Gautier, J. H., & Co., Jersey City.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
McCormick Co., J. S., Pittsburg, Pa.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.
Ross-Tacony Crucible Co., Philadelphia, Pa.
Smith, J. D., Foundry Supply Co., Cleveland.
Whitehead Bros. Co., Providence, New York, Buffalo.

PNEUMATIC TOOLS.

Independent Pneumatic Tool Co., Chicago, Ill.
Pittsburg Pneumatic Tool Co., Pittsburg, Pa.

POLISHING MACHINES.

Osborn Mfg. Co., Cleveland, O.

POLISHERS' AND PLATERS' SUPPLIES.

Levett Mfg. Co., Matawan, N. J.
Stevens, Frederic B., Detroit, Mich.

POLISHING OUTFITS.

(Stoves.)
Coates Clipper Mfg. Co., Worcester, Mass.

RAMMERS.

(Bench.)
Ingersoll-Rand Co., New York, N. Y.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.

RAPPING PLATES.

Paxson Co., J. W., Philadelphia, Pa.

RIDDLES.

Adams Co., Dubuque, Iowa.
Federal Fdry. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Whitehead Bros. Co., Providence, New York, Buffalo.

RUNWAYS.

(Crane.)
Whiting Fdy. Equipment Co., Harvey, Ill.

SAND.

Brass Founders' Supply Co., Newark, N. J.
Buffalo Foundry Supply Co., Buffalo, N. Y.
Detroit Core Sand Co., Detroit, Mich.
Federal Fdy. Supply Co., Cleveland, O.
Interstate Sand Co., Zanesville, O.
McCormick, J. S., Co., Pittsburg, Pa.
Newport Sand Bank Co., Newport, Ky.
Obermayer, S., Co., Cincinnati, O.
Ohio Sand Co., Conneaut, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Bros., Bethlehem, Pa.
Standard Sand & Mch. Co., Cleveland, O.
Tuscora Sand Co., Cleveland, O.
Whitehead Bros. Co., Providence, New York, Buffalo.

SAND.

(Silica.)
International Pulp Co., New York City.

SAND BLASTS.

American Diamond Blast Co., New York City.
Farnham Sand Blast Co., New York, N. Y.
High Pressure Sand Blast Co., New York City.

SAND BLAST MACHINERY.

American Diamond Blast Co., New York City.
Betton, J. M., New York, N. Y.
High Pressure Sand Blast Co., New York City.
Niagara Device Co., Buffalo, N. Y.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa.

SAND BLAST SYSTEMS.

American Diamond Blast Co., New York City.
High Pressure Sand Blast Co., New York City.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa.

SAND BLAST TUMBLING BARRELS.

Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa.

SAND MIXING MACHINERY.

Falls Rivet & Machine Co., Cuyahoga Falls, O.
Mumford Molding Machine Co., New York.
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Sand Mixing Machine Co., New York City.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Standard Sand & Mch. Co., Cleveland, O.

SAND SIFTERS.

Deane Steam Pump Co., Holyoke, Mass.
Hanna Engineering Works, Chicago, Ill.
Herman Pneumatic Mach. Co., Zelienople, Pa.
Hill & Griffith Co., Cincinnati, O.
Killing Molding Machine Co., Davenport, Ia.
McCormick, J. S., Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Pangborn Company, Thomas W., New York.
Paxson, J. W., Co., Philadelphia, Pa.
Turner Machine Co., Philadelphia, Pa.

SAWS.

(Cold Cutting.)
Quincy, Manchester, Sargent Co., Plainfield, N. J.
Tabor Mfg. Co., Philadelphia, Pa.

SCREENS.

(Sand.)
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.

SEACOAL.

Buffalo Foundry Supply Co., Buffalo, N. Y.
Federal Fdy. Supply Co., Cleveland, O.
Keystone Foundry Supply Co., Buffalo, N. Y.
Obermayer, S., Co., Cincinnati, O.
Paxson Co., J. W., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co., Providence, New York, Buffalo.

SEPARATORS.

(Magnetic.)
Obermayer, S., Co., Cincinnati, O.
Pangborn Company, Thomas W., New York.
Paxson Co., J. W., Philadelphia, Pa.

SHAFTING.

(Flexible.)
Stow Mfg. Co., Binghamton, N. Y.

SHOVELS.

Federal Fdy. Supply Co., Cleveland, O.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
McCormick, J. S., Co., Pittsburg, Pa.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Whitehead Bros. Co., Providence, New York, Buffalo.

SKIMMING DEVICES.

Metal Dross Economy Co., Bristol, Conn.

SPELTER.

Vernon Metal Co., New York City.

SPRINGS.

(Vanadium.)
American Vanadium Co., Pittsburg, Pa.

SPRUE CUTTERS.

Barnett, Oscar, Foundry Co., Newark, N. J.
Brass Founders' Supply Co., Newark, N. J.
Shuster, F. B., Co., New Haven, Conn.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Turner Machine Co., Philadelphia, Pa.

STARS.

(Hard Iron.)
Cleveland Nickel Works, Cleveland, O.

STEEL.

(Vanadium.)
American Vanadium Co., Pittsburg, Pa.

STOPPERS.

Bartley, Jonathan, Crucible Co., Trenton, N. J.
Dixon, Jos., Crucible Co., Jersey City, N. J.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.
Ross-Tacony Crucible Co., Philadelphia, Pa.

SWABS.

(Molders'.)
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.

TALC.

International Pulp Co., New York City.

TAPERS.

Paxson Co., J. W., Philadelphia, Pa.

TESTING MACHINES.

Keep, W. J., Detroit, Mich.

TONGS.

(Crucible.)
Paxson Co., J. W., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.

TOOLS.

(Molders'.)
Dobson, William, Canastota, N. Y.
Federal Fdy. Supply Co., Cleveland, O.
Obermayer, S., Co., Cincinnati, O.
Osborn Mfg. Co., Cleveland, O.
Paxson Co., J. W., Philadelphia, Pa.
Peninsular Tool & Specialty Co., Detroit.

TOOLS.

(Pneumatic.)
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Niagara Device Co., Buffalo, N. Y.

TORCHES.

Hauck Mfg. Co., Brooklyn, N. Y.
Paxson Co., J. W., Philadelphia, Pa.

TRACK.

(Industrial.)
Whiting Fdy. Equipment Co., Harvey, Ill.

TRAMRAIL SYSTEMS.

Northern Engineering Works, Detroit, Mich.
Paxson, J. W., Co., Philadelphia, Pa.
Randall Tramrail Co., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

TROLLEYS.

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

TROLLEY SYSTEMS.

Smith, J. D., Fdy. Supply Co., Cleveland, O.

TRUCKS.

Northern Engineering Works, Detroit, Mich.

TUMBLING BARRELS.

Northern Engineering Works, Detroit, Mich.
Paxson Co., J. W., Philadelphia, Pa.
Smith, J. D., Fdy. Supply Co., Cleveland, O.
Whiting Fdy Equipment Co., Harvey, Ill.

TUMBLING MILLS.

Adams Co., Dubuque, Iowa.
Calumet Engineering Works, Harvey, Ill.
Cleveland Nickel Works, Cleveland, O.
Falls Rivet & Mach. Co., Cuyahoga Falls, O.
Sly, W. W., Mfg. Cleveland, O.

TUNGSTEN METAL.

Primos Chemical Co., Primos, Pa.

TURBINES.

(Steam.)
Kerr Turbine Co., Wellsville, N. Y.

TURNTABLES.

Northern Engineering Works, Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.

VANADIUM.

American Vanadium Co., Pittsburg, Pa.

VENTILATORS.

Royal Ventilator & Mfg. Co., Philadelphia, Pa.

VIBRATORS.

(Compressed Air.)
Osborn Mfg. Co., Cleveland, O.

WAX

(Core.)
United Compound Co., Buffalo, N. Y.

WAX WIRE.

Field & Co., Alfred, New York City.
Kelly, T. P., & Co., New York, Chicago, Hamilton.
Paxson Co., J. W., Philadelphia, Pa.

WELDING AND EQUIPMENTS.

(Oxy-Acetylene.)
Goodyear, Nelson, Inc., New York, N. Y.
Oxy-Acetylene Appliance Co., New York.

WELDING APPARATUS.

(Oxy-Acetylene.)
Goodyear, Nelson, Inc., New York, N. Y.

WHITE FINISH.

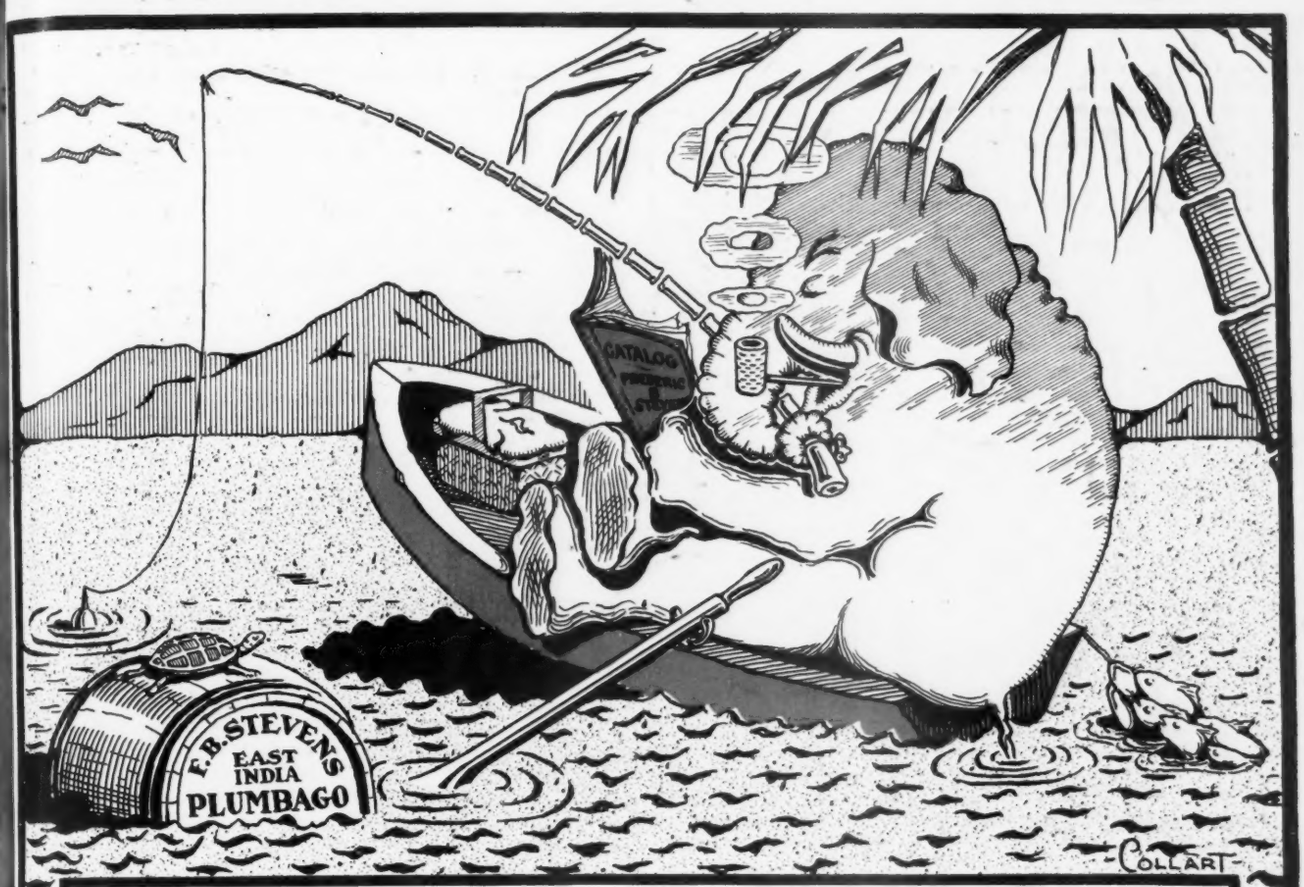
Osborn Mfg. Co., Cleveland, O.

WIRE CLEANING WHEELS.

Osborn Mfg. Co., Cleveland, O.

WIRE STRAIGHTENERS.

Blake, Geo. F., Mfg. Co., New York City.
Pangborn Company, Thomas W., New York.
Shuster, F. B., Co., New Haven.



Between - Times!

This is the between hay and grass season, otherwise known as the summer solstice.

There are those who rest and those who work while they rest, and all work either directly or indirectly---indirectly, the Foundry turns out its daily quota while its proprietor tries to catch fish.

To have the Foundry save the shekels and bring in the shekels---double duty---it should be supplied with **King Kore Kompound.**

It's a black dry powder and it overcomes all the evils that others are heir to. It utilizes old gangway sands; it is free from odor and the core comes out easily; its cost is lower than other similiar costs.

This compound was born of necessity---perfected by experience. It is well established in thirteen states---with thirteen at least---of course a good many more---kinds of core sands. A core compound that will behave under such conditions is just about right. In these days of high prices of Flour, Rosin, and other old-fashioned things, this compound is a boon.

It reduces the science of making a hollow casting to simplicity, and elevates the simplicity of core making to a science.

Entirely different from any other; it travels in a class by itself.

It costs nothing to try a barrel, so here is the door of opportunity standing wide open.

You can walk in by writing me.

I manufacture Foundry Facings, Foundry Supplies, and Polishers' and Platers' Supplies.

FREDERIC B. STEVENS

DETROIT, MICHIGAN

FACING MILLS
Cor. Isabella Ave. and M. C. R. R.

WAREHOUSE AND OFFICES
Cor. Larned and Third Sts.

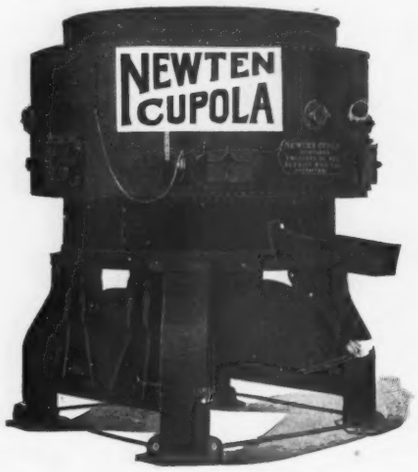
EXPORT WAREHOUSE
Windsor, Ontario

The Cupola of Satisfaction

(THE NEWTEN)

Some testimony that talks

"Acknowledging yours of March 29th, we beg to advise that our experience with the Newten Cupola has been very satisfactory indeed. If we were to install new equipment in this direction, we should introduce the same cupola again."



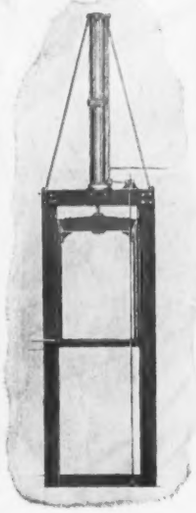
"We are using two of the No. 60 Newten Cupolas, and we like them very much. We don't think there is any better made. If we were to buy again we would get the 'Newten'."

"We are pleased to say that the Newten Cupola is giving excellent results. Should we need another cupola, we assure you that we would not hesitate to duplicate our order for a Newten."

SEE CATALOG NO. 51

NORTHERN ENGINEERING WORKS.
DETROIT. MICH. U.S.A.

Lift Your Lighter Loads



Air Elevator

with our ***AIR HOISTS*** and ***AIR ELEVATORS***

There are many places around your plant where loads are light but too heavy for man power, and where lifts are of moderate height. Our Compressed Air Cylinder Hoists will do this work cheaper than any other power. They are handy on small cranes as well.

Air Hoist

BULLETIN NO. 34

NORTHERN ENGINEERING WORKS.
DETROIT. MICH. U.S.A.

Buy Cranes of the Non-Accident Type

NORTHERN CRANES

Yes, your Electric Foundry Crane should be of the "enclosed gearing" design---but that isn't all. ***In what way is it enclosed?***

Our Type E Method is the kind you should see---then compare. "You will search in vain for a better crane."

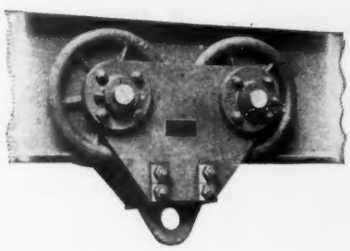
BULLETIN E
We also make hand cranes
Catalog No. 25

NORTHERN ENGINEERING WORKS.
DETROIT. MICH. U.S.A.

New York, 120 Liberty St. Chicago, Monadnock Blk.
Pittsburg, Machesney Bldg.

Our Canadian branch is the Advance Machine Works, Ltd., Walkerville, Ont.

Are You Considering an Overhead Tramway System?



You should learn about our overhead roller bearing trolleys for such systems.

We install, also, the complete track system with curves, switches and turntables.

New designs based on twenty years experience.

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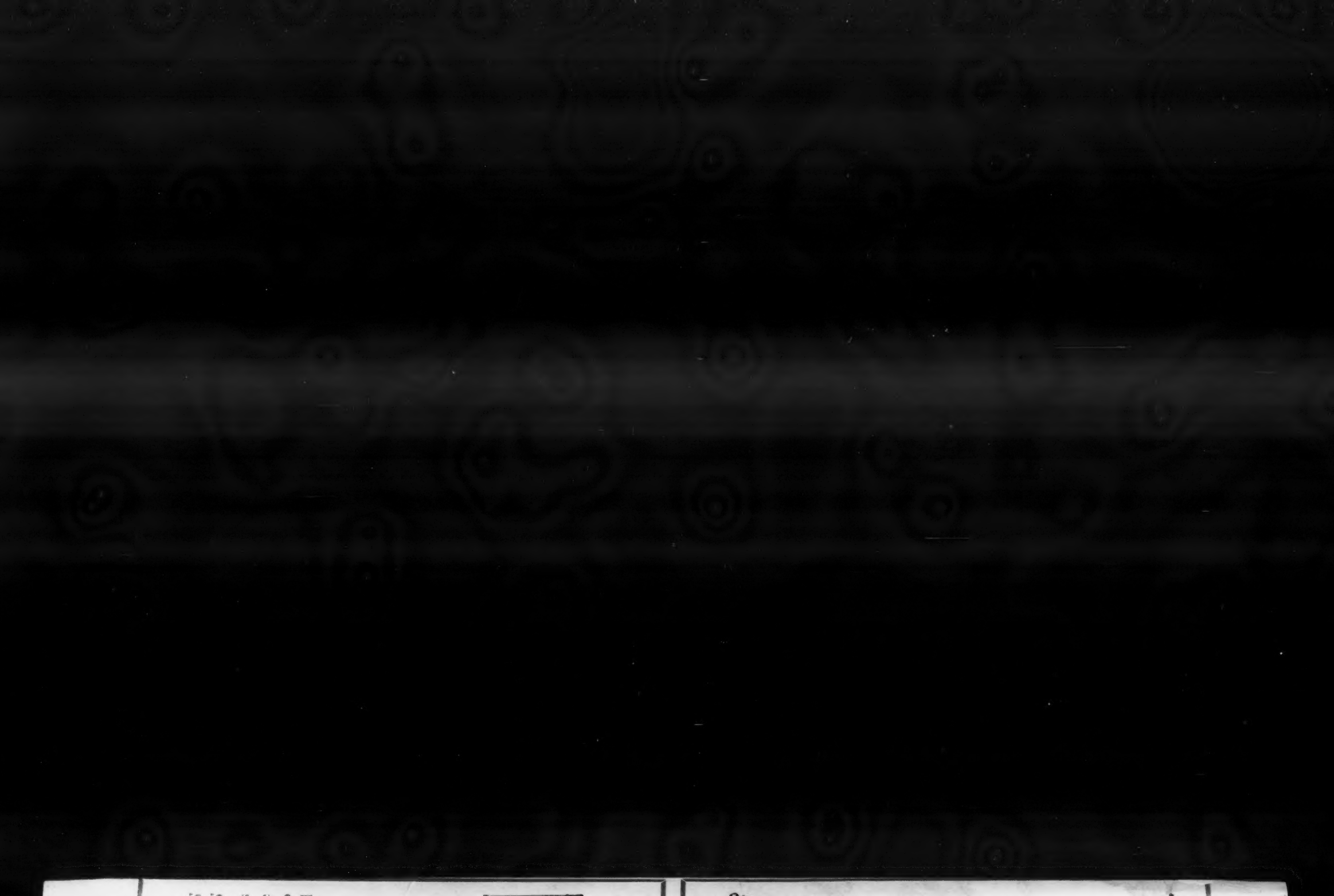
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DETROIT. MICH. U.S.A.